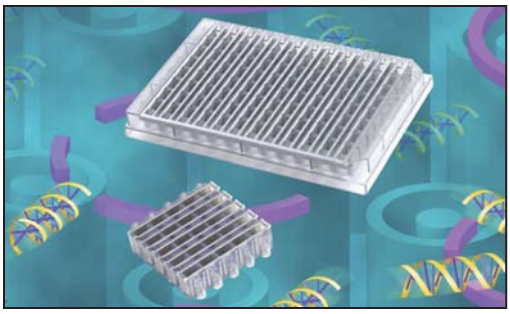
Cell Biology

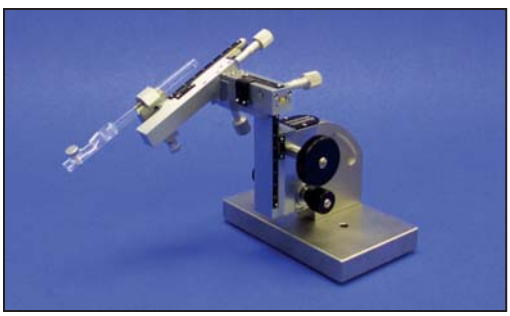
NEW 6-Channel Oxygen System Model 928, see page M18



NEW MOS 25 and MOS 96 Advanced Electroporation Systems, see page M55

NEW ZonaDrill™ Laser System, see page M74

NEW SC-20 Dual In-Line Solution Heater/Cooler, see page M130



NEW Dovetail Slide Micromanipulators, see page M191

NEW **Nitric Oxide Measurement Systems** ..... *see pages M2 – M5*

NEW **Oxygen Measurement Systems** ..... *see pages M6 – M14*

NEW **Respirometry Systems** ..... *see pages M15 – M22*

- **pH and Reference Electrodes** ..... *see pages M23 – M31*
- **Microelectrode Holders** ..... *see pages M32 – M44*
- **Capillary Glass** ..... *see pages M45 – M49*
- **Micropipette Pullers** ..... *see pages M50 – M54*

NEW **Electroporation Products** ..... *see pages M55 – M61*

NEW **Electroporation Electrodes and Accessories** ..... *see pages M62 – M69*

NEW **Microinjection and Microperfusion Systems** ..... *see pages M70 – M79*

- **Micro-Incubation Products** ..... *see pages M80 – M86*

NEW **Chambers for 35mm Cell Culture Dishes** ..... *see pages M87 – M93*

NEW **Special Chambers Systems** ..... *see pages M94 – M111*

NEW **Chamber Platforms and Stage Adapters** ..... *see pages M112 – M123*

NEW **Temperature Controllers** ..... *see pages M124 – M129*

NEW **Temperature Controller Peripherals** ..... *see pages M130 – M134*

NEW **Perfusion Controllers** ..... *see pages M135 – M148*

NEW **Microscopes and Illuminators** ..... *see pages M149 – M159*

NEW **Tissue Sampling Systems** ..... *see pages M160 – M165*

NEW **Diffusion (Ussing) Chambers** ..... *see pages M166 – M175*

NEW **Voltage/Current Clamps** ..... *see pages M176 – M185*

NEW **Micromanipulation Products** ..... *see pages M186 – M201*

- **Cell Biology Books** ..... *see page M202*

NEW inNO-T Nitric Oxide Measurement System

- NEW Dual Channel System
- Uses 'amiNO' sensors which are up to 100 times more sensitive than others on the market today
- inNO-T system is the first available NO system to have temperature compensation
- inNO-T system virtually eliminates base line drift due to temperature changes
- Combination NO meter and data acquisition system
- Battery-powered benchtop/portable system (5 year battery life)
- 24 bit A/D converter for the widest dynamic range (16,000,000 to 1)
- User friendly recording, playback and analysis
- Software compatible with Windows™ 95/98, 2000 and NT
- Continuous recordings (over 1 month)
- System shipped complete with NO meter, software, 2 types of NO sensors, and calibration kit
- Auto zero
- Computer chart recorder
- RS-232 interface
- Digital filter
- Menu driven commands

inNO-T Nitric Oxide Measurement System

The 'inNO-T' system is the most technologically advanced nitric oxide electrochemical detection system on the market today. It combines a nitric oxide configured potentiostat and a sophisticated software controlled data acquisition system in one compact battery powered unit. When used with the 'amiNO' series of NO sensors, this unit provides an NO detection sensitivity increase of up to 100 times that of any other electrochemical detection system on the market today. Its state of the art battery powered design allows the unit to run continuously for up to 5 years, making it ideal for any electrically isolated and/or portable application.

The 'inNO-T' system is the first available nitric oxide system to include temperature compensation which further enhances the detection limits and data reliability by virtually eliminating baseline drift caused by temperature changes. A temperature probe is supplied with each system. Its internal 24 bit analog to digital converter and built in digital notch filtering allows for accurate, noise free, detection of Nitric Oxide levels of less than 0.01 nM. The 24 bit A/D technology also gives the unit a dynamic range in excess of 16,000,000 to 1. Its sophisticated control and analysis software can be linked to any computer system that utilizes Windows™ 95/98, 2000 or NT via the 'inNO's' internal RS-232 interface.

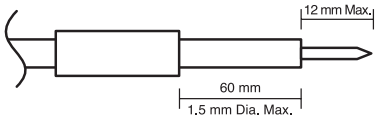
'amiNO' Series of Nitric Oxide Sensors

- All NO sensors are combination sensors, no external reference electrode required
- Mechanically rugged membrane
- All sensors covered with proprietary triplecoat gas permeable membrane to guarantee selectivity and very fast response time
- All sensors completely shielded from environmental/electrical noise
- All sensors work the 'inNO-T' meter as well as many other currently available meters
- One calibration procedure, simple, easy, no expensive chemicals

Using the latest state of the art combination NO sensor design, the 'amiNO' series of nitric oxide sensors increases the sensitivity of electrochemical nitric oxide measurement, by up to 100 times that of any existing electrochemical sensor on the market today. They are the first NO sensors to break the 100 pA/nM barrier, see chart on page M4. This higher sensitivity greatly reduces any measurement errors due to baseline drift associated with temperature changes. This baseline drift has been a particular concern with older technology sensors that do not have the enhanced sensitivity characteristics of the 'amiNO' sensors. Additionally the new 'amiNO' series adds newly designed sensor types for application involving in-vivo and large surfaces (cultured cells). Customized sensors are available upon request to meet specialized applications, call Harvard Apparatus Customer Service for details. Harvard Apparatus offers 4 different Nitric Oxide Measurement Systems. Each system includes either a 1-channel or 2-channel inNO-T Temperature compensated meter plus an BS4 69-0012 amiNO-2000 sensor, BS4 69-0016 SensoReady Electrode Polorizer and a temperature probe (for a complete listing of system components see chart on page M4). Each system is offered in either 115 or 230 VAC.

A gas phase NO sensor is currently under development, please call for details.

NEW inNO-T Nitric Oxide Measurement System



amiNO-7 Sensor

- 7 µm tip diameter
- Ideal for single cell measurements
- Metal alloy fiber
- Tip Volume ~ 500µl

amiNO-30 Sensor

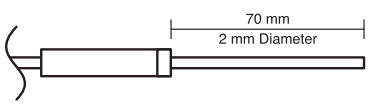
- 30 µm tip diameter
- For space restricted measurements
- Metal alloy fiber
- Tip Volume ~ 10µl

amiNO-100 Sensor

- 100 µm tip diameter
- Extremely stable background
- Resists breakage
- To be used in restricted areas and 'in vivo' measurements
- Very consistent & reproducible
- Tip Volume ~ 100µl

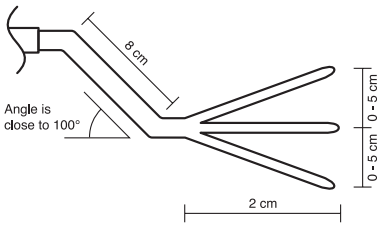
amiNO-600 Sensor

- 600 µm tip diameter
- Exceptional sensitivity and baseline stability
- Very rugged membrane, flexible body
- Very durable
- Tip Volume ~ 4µl



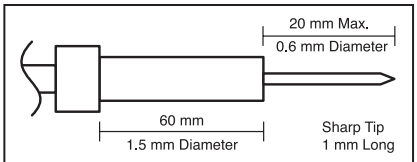
amiNO-2000 Sensor

- Flat 2 mm tip diameter
- Stainless steel/aluminum body
- Longest life NO electrode (user replaceable membranes)
- Tough enough for training new staff and students
- Used to measure high levels of NO as in drug solutions and macrophages
- Tip Volume ~ 250µl



amiNO-FLAT Sensor

- Designed specially for measuring NO released from monolayer cultured cells and large flat tissues
- Rugged membrane
- Highest sensitivity
- Low background



amiNO-IV Sensor

- 600 µm tip diameter
- Very sharp metallic tip for insertion/penetration of tissue, no extra needles or catheters are needed, sensor is the needle
- Higher sensitivity, up to 100 times more sensitive than other commercially available sensors
- Sub nano-molar detection limit
- Special membrane survives numerous insertions
- Very stable, low background current
- Tip Volume ~ 6µl

BS4 69-0016 'SensoReady' Electrode Polarizer

*Please refer to the guide below to help you select the best sensor for your application. For additional assistance, please call Harvard Apparatus Technical Support.**

**The selection guide below is based on design, sensitivity and economy. For example, amiNO-FLAT and amiNO-IV are the most sensitive but are also the most expensive. The amiNO-600 is less sensitive but is more economical.*

amiNO Sensor Selection Guide*

Application	First Choice(s)	Second Choice(s)
Measuring NO released from cells/large flat tissue	amiNO-FLAT	amiNO-600 or amiNO-IV
In vivo measurements and other insertion applications	amiNO-IV	amiNO-600
Measuring NO in small volumes or restricted space	amiNO-100	amiNO-7, amiNO-30 or amiNO-600
Measuring micro-molar levels of NO	amiNO-2000	amiNO-100 or amiNO-30
Following the decomposition of an NO producing compound	amiNO-600 or amiNO-100	amiNO-2000 or amiNO-IV
Measuring very low levels of NO (below 50 nM)	amiNO-600 or amiNO-IV	amiNO-100
Indirect measurement of Nitrate and Nitrite	amiNO-600, depending on expected level	amiNO-100 or amiNO-2000
Training new staff or students	amiNO-2000	amiNO-600

* *Note: Room Temperature Sensitivities — The above selection guide is based on design, sensitivity and economy. For example, amiNO-FLAT and amiNO-IV are the most sensitive, but are also the most expensive. The amiNO-600 is less sensitive, but is more economical.*

NEW inNO-T Nitric Oxide Measurement System

Specifications

Current Scale	±2,500,000.0 pA
Concentration Scale	±1,000,000.0 nM
Resolution	0.01 nM (0.1 pA)
Screen Meter	7.5 digit meter
Recording Speed	1 to 1000 sec/div
Power	Replaceable battery
Dimensions, H x W x D	76 x 229 x 203 mm (3 x 9 x 8 in)
Temperature Range	0° to 50°C, inNO-T only
Temperature Resolution	0.01°C, inNO-T only
Temperature Sensor	< 0.50 mm tip, 120 mm long, inNO-T only

Catalog No.	$	Product
BS4 69-0013		Electrolyte
BS4 69-0014		Replacement Membranes for BS4 69-0012, pkg. of 4
BS4 69-0016		SensoReady Electrode Polarizer
BS4 69-0029		Adapter, LIMO Connector to amiNO Sensor Connector

Note: inNO and inNO-T are battery operated. Voltage selection is for Magnetic Stirrer. Call Harvard Apparatus Customer Service for Nitrate Reduction Products.

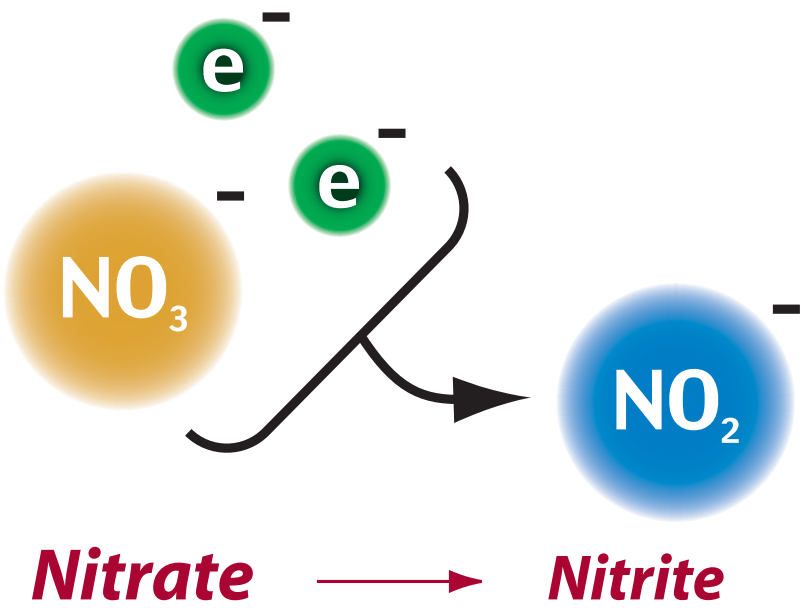
amiNO Sensor Performance Comparison and Ordering Information

Catalog No.	$	Quantity	Model	Size	Typical Sensitivity	Competitor Typical Sensitivity
BS4 69-0008		2	amiNO-7	7 µm	0.5-3 pA/nM (typical 1.5 pA/nM)	n/a
BS4 69-0009		2	amiNO-30	30 µm	2-6 pA/nM (typical 4 pA/nM)	n/a
BS4 69-0010		2	amiNO-100	100 µm	25 to 50 pA/nM (typical 35 pA/nM)	No Equivalent
BS4 69-0011		2	amiNO-600	600 µm	150 to 250 pA/nM (typical 200 pA/nM)	No Equivalent
BS4 69-0012		1	amiNO-2000	2 mm	Typical 1 pA/nM	Typical 1 pA/nM
BS4 69-0006		2	amiNO-IV	600 µm	150 to 250 pA/nM (typical 200 pA/nM)	No Equivalent
BS4 69-0007		1	amiNO-FLAT	See diagram	250 to 700 pA/nM (typical 400 pA/nM)	No Equivalent

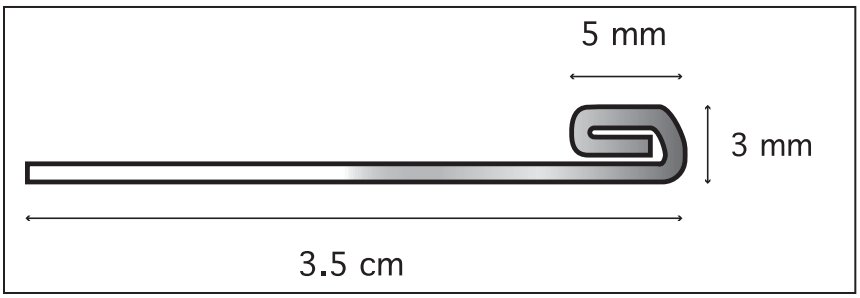
inNO-T Nitric Oxide Measurement Systems

Sensors and Accesories Catalog No.	$	System Components	Premium System #1 115 VAC, 60 Hz	Premium System #1 230 VAC, 50 Hz	Premium System #2 115 VAC, 60 Hz	Premium System #2 230 VAC, 50 Hz	Premium System #3 115 VAC, 60 Hz	Premium System #3 230 VAC, 50 Hz	Premium System #4 115 VAC, 60 Hz	Premium System #4 230 VAC, 50 Hz
BS4 69-0012		amiNO-2000 Nitric Oxide Sensor, 2 mm Tip	•	•	•	•	•	•	•	•
BS4 69-0010		amiNO-100 Nitric Oxide Sensor, 100 µm Tip, pkg. of 2	•	•						
BS4 69-0011		amiNO-600 Nitric Oxide Sensor, 600 µm Tip, pkg. of 2			•	•				
BS4 69-0006		amiNO-IV Nitric Oxide Sensor, In-Vivo 600 Micrometer Tip, pkg. of 2					•	•		
BS4 69-0007		amiNo-FLAT Nitric Oxide Sensor, Flat 25 x 25 mm, pkg. of 1							•	•
BS4 69-0013		Electrolyte for BS4 69-0012	•	•	•	•	•	•	•	•
BS4 69-0014		Replacement Membranes for BS4 69-0012, pkg. of 4	•	•	•	•	•	•	•	•
BS4 69-0037		Nitrite Standard, 50 ml	•	•	•	•	•	•	•	•
BS4 69-0038		Calibration Vials, pkg. of 5	•	•	•	•	•	•	•	•
BS4 69-0016		SensoReady Electrode Polarizer	•	•	•	•	•	•	•	•
BS4 72-0460		Spin Bar Magnetic Stir Bar, 5 x 2 mm, pkg. of 5	•	•	•	•	•	•	•	•
BS4 72-1920		Magnetic Stirrer, 115 VAC	•		•		•		•	
BS4 72-1921		Magnetic Stirrer, 230 VAC		•		•		•		•
BS4 72-1922		Electrode Holder and Stand	•	•	•	•	•	•	•	•
Systems										
		1-Ch inNO System with inNO-T Meter with Temp. Compensation	**BS4 69-3050 $**	**BS4 69-3051**	**BS4 69-3052**	**BS4 69-3053**	**BS4 69-0048**	**BS4 69-0049**	**BS4 69-0050**	**BS4 69-0051**
		2-Ch inNO System with inNO-T Meter with Temp. Compensation	**BS4 69-3054 $**	**BS4 69-3055**	**BS4 69-3056**	**BS4 69-3057**	**BS4 69-3058**	**BS4 69-3059**	**BS4 69-3060**	**BS4 69-3061**

NEW Nitrate Reductor



- Never needs reactivation, even after hundreds of samples!
- No need to bring the sample to the reductor; take the reductor to the sample. This eliminates the need for sample transfer which saves time and eliminates sample loss
- Can be used in any sample container such as a vial, tube, micro-plate well or spectrophotometric cell
- Very small; virtually no minimum sample volume restriction required... It can be used in 50 microliters or 5 milliliters
- 100% conversion in minutes
- Very economical
- Reusable



The measurements of nitrate and nitrite anions in biological samples have gained more interest due to their association with the nitric oxide (NO) pathway. Since these ions are the oxidation products of NO, their presence can be used as an indicator of NO production activities.

There are many methods available for both direct and indirect measurement of nitrite. Unfortunately, this is not the case for nitrate due to its different chemical reactivity. Therefore, most of the analytical procedures involving nitrate include its conversion to nitrite using either enzymatic reduction or cadmium-based reductors. These conversion procedures are tedious, time consuming, expensive, require multiple sample transfer, and suffer from diminished activity.

Our NEW Nitrate Reductor is specifically designed to overcome these shortcomings.

Principle of Operation

Conventional bimetallic composition based reductors are based on copper-plated cadmium beads. The presence of copper metal alters the potential energy of the cadmium electrons enhancing the rate of their transfer to nitrate. Even though this design has been used successfully for many years, it has two main drawbacks. The loss of its catalytic activity after using it on a number of samples requires that the reductor be reactivated. The second problem deals with the difficulty in handling and utilizing the beads for use with very small sample volume containers to avoid diluting the sample because these beads are normally packed in a column.

Our nitrate reducing wire is based on a multi-metal alloy structure. This multi-metallic structure preserves the activity of the reductor and enhances the rate of electron transfer in these chemical reactions:

$$M \rightarrow M^{+2} + 2\,e$$

$$NO_3^- + 2\,e + H_2O \rightarrow NO_2^- + 2\,OH^-$$

This alloy structure completely eliminates the need to ever reactivate the nitrate reductor. The design of the reductor in the form of a wire enables it to be used on very small sample volumes and removes the restriction of having to move your sample to a specialized container.

The reductor is available in two different kit forms. The manual kit includes 6 reductors that are used to reduce nitrate in 6 samples simultaneously. The motorized kit is a combination of a reductor and a mixer. The mixer is the reductor! The reductor is the mixer. It is ideal for use in sample containers where stirring is difficult. The motorized reductor reduces nitrate faster than the manual kit version. The motorized version has a removable reductor and comes with a micro-sleeve enabling the user to utilize it as a micro-mixer in the lab.

Catalog No.	$	Product
BS4 69-0054		Manual Nitrate Reductor Kit, pkg. of 6
BS4 69-0055		Motorized Nitrate Reductor Kit

NEW Dissolved Oxygen Meter and Electrodes

BS4 69-0026 Dissolved Oxygen Meter shown with Stirrer and Electrode Stand, not included

Dissolved Oxygen Meter

- Meter offers a "clean" function to reactivate the electrode
- Measures O_2 in either liquids or gas phase
- Battery operated/isolated meter
- Replaceable membranes

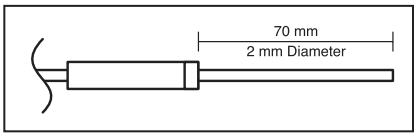
This dissolved oxygen measuring system utilized the latest technologies in electronic circuitry and chemical sensors. Using the 2 mm stainless steel-tip electrode oxygen can be measured in either liquid solution or gas phase. The BS4 69-0027 2 mm stainless steel electrode, see to the right, is supplied with each system with two replacement membranes and electrolyte. The meter can display current, percentage, or PPM oxygen. The meter offers an activation function to restore the activity of the sensor without the need of polishing and conditioning.

Specifications

% O_2	0 to 100%
PPM	0 to 20
Current Range	0 to 2000 nA
Resolution	0.1 PPM, 0.1 %
Accuracy	±1%
Recorder Output	Analog output 0 to 5 V
Electrode Response Time	Under 10 sec, 90% response in stirred solution
Display	3.5 digit LCD
Power	120/240 VAC
Dimensions	20.3 x 22.9 x 76.2 cm (8 x 9 x 3 in)
Shipping Weight	2 lb (1.5 kg)

Catalog No.	$	Product
BS4 69-0026		Oxygen Meter with Temperature Compensation and 2 mm Oxygen Electrode
BS4 69-0028		Replacement O_2 Membranes, pkg. of 4
BS4 72-1920		Magnetic Stirrer, 115 VAC
BS4 72-1921		Magnetic Stirrer, 230 VAC
BS4 72-1922		Electrode Holder and Stand

2 mm Oxygen Electrode



Specifications

Cable and Connector	3.5 mm x 6 ft (D x L)
Handle	6.4 x 50 mm (D x L)
Tip	Stainless steel, 2 x 70 mm (D x L) with flat sensing tip

Cat No.	$	Product
BS4 69-0027		Oxygen Electrode, 2 mm
BS4 69-0028		Replacement O_2 Membranes, pkg. of 4

For more Oxygen Detection Systems, see pages M7-M14. Sub-millimeter sensors are available by special order.

Phosphorescence O_2 Measurement System

PMOD 2000

The PMOD-2000 uses a noninvasive optical method for detecting the concentration of O_2 in tissue. The operating principle for the unit is based on the quenching of phosphorescence by oxygen in phosphors that have been injected into the blood. To determine the concentration of O_2 in the area of tissue being measured, phosphorescence lifetime measurements are taken using a sinusoidally modulated light source for excitation and frequency lock for phosphorescence detection. The PMOD operates over a frequency range from 200 to 20,000 Hz, allowing measurements of phosphorescence lifetimes from <15 microseconds to 1.5 milliseconds. Measurements can be carried out either at constant frequency or constant phase shift. This technique differs from other methods of O_2 detection in that this method is totally noninvasive, with the fiber optic bundle outside of the tissue in which the O_2 is being measured. The PMOD-2000 has a very high accuracy throughout the physiological range and provides real time measurements with high temporal resolution (~1 sec/measurement). The phosphors that are used with this system have absolute calibration and follow Stern-Volmer behavior. Once a phosphor is calibrated for a given temperature and solvent conditions these values are stable, eliminating the possibility of measurement drift and the requirement for re-calibration at the time of the measurement.

The system has two channels (sources) of excitation light. The standard system comes with one wavelength set to 524 nm (suitable for the porphyrin based phosphors) and 635 nm (suitable for the tetrabenzoporphyrin based phosphors). Other combinations of excitation wavelengths are available. Please call our technical sales department for further information.

Phosphorescence emission is in the range of 660 to 760 nm (porphyrins) or 760 to 900 nm (tetrabenzoporphyrins). Since bright ambient light can saturate the detector, it is recommended that the work area be lighted with DC powered monochromatic light sources. The 'Cool Colors' LED lamps are specifically designed for this purpose. When an appropriate lamp is used, this light does not interfere with the phosphorescence measurements.

- Two built-in light sources; one for surface (0.5 to 1 mm) and one for deep tissue (2 to 3 cm) measurements
- Noninvasive oxygen measurements in tissue in-vivo or in-vitro
- Linear relationship between 1/lifetime and pO_2
- Stable over time, no sensitivity or baseline drift
- Absolute calibration; calibrate only once
- Windows operating environment
- Temporal resolution < 1.2 sec/measurement
- Evaluate a wide range of tissue physiology and pathology
  - — Vascular and cardiopulmonary function
  - — Tumor oxygenation
  - — Status of skin grafts
  - — Diabetic vascular complications
  - — Ischemia/reperfusion injury, etc.
- Visible and near infrared phosphors for different tissue depth measurements
- Measurements in-vitro in sealed glass chambers, no oxygen exchange with the environment

Types of Phosphors and Phosphor Kits Available

Pd-meso-tetra (4-carboxyphenyl) porphyrin
This phosphor (Oxyphor RO) is dissolved in the presence of 0.5% or greater of bovine serum albumin. It provides excellent oxygen sensitivity and has been accurately calibrated (see Lo et al., 1996). This phosphor has an absorption band near 524 nm and emission near 690 nm and can be used for surface O_2 measurements in tissues.

Lyophilized Porphyrin Kit*
1.2 g. approx. amount needed for approx. 30 rat (rats weighing 300 g each) and 10 cat (cats weighing 3 kg each) experiments using the PMOD instrument. Lyophilized porphyrin contains (approx.): 9% Pd-meso-tetra (4-carboxyphenyl) porphine which is bound to 80% BSA (clinical grade, low fatty acid), 8% NaCl, and 3% TRISMA buffer. Accessories include one (1) 10 cc syringe, three (3) syringe filters (25 x .22 micron), and three (3) 4.0 mL amber glass vials with foil caps.

Pd-meso-tetra (4-carboxyphenyl) porphyrin dendrimer
Oxyphor R2: This new water soluble phosphor has significant advantages over the parent compound for experiments in vivo. The quenching properties are similar to those of the parent compound with respect to the effect of albumin. However, because it is highly water soluble it can be injected into the blood as a simple solution in physiological saline. The pH dependence of Oxyphor R2 is also very small over the physiological range (see Lo et al., 1997). Oxyphor R2 is largely excreted in the urine in mice and other animals. In mice, excretion occurs with a half time of less than 2 hours.

Pd-tetra-(4-carboxyphenyl) tetrabenzoporphyrin dendrimer
Oxyphor G2: This is a water soluble phosphor that has an absorption band near 636 nm and emission near 800 nm and can be used for O_2 measurements in tissue up to 3 cm thick.

Phosphorescence O_2 Measurement System

The 'Cool Colors' LED lamps are specifically designed for this purpose. When an appropriate lamp is used, this light does not interfere with the phosphorescence measurements.

The Windows compatible software included with the PMOD-2000 system is used to configure the system's parameters and to display and store the measurement frequency, signal amplitude, phase, and time of measurement as well as the oxygen pressure. The time course of phosphorescence lifetime or oxygen pressure can be continuously plotted on screen as the data are taken. All of the displayed signal parameters can be saved to named files for further analysis etc. The files are in ASCII and are easily read by other programs such as Excel®, Sigma Plot®, etc. Systems come complete with a 6 mm OD bifurcated optical fiber cable. Other optical fiber configurations are also available, please call our technical sales department for additional information.

Computer Requirements: The operating software is for DOS or Windows 95/98/NT and requires an IBM compatible PC. Only the Windows NT version will allow determination of the distribution of phosphorescence lifetimes. In any case, communication with the computer requires a 16550 UART serial port (or later).

Method Reference Publications:

1) *Vanderkooi, J.M., Maniara, G., Green, T.J., and Wilson, D.F. An optical method for measurement of dioxygen concentration based on quenching of phosphorescence. J. Biol. Chem. 262: 5476-5482, 1987.*
2) *Wilson, D.F., Rumsey, W.L., Green, T.J., and Vanderkooi, J.M. (1988) The oxygen dependence of mitochondrial oxidative phosphorylation measured by a new optical method for measuring oxygen. J. Biol. Chem. 263: 2712-2718.*
3) *Robiolio, M., Rumsey, W.R. and Wilson, D.F. (1989) Oxygen diffusion and mitochondrial respiration in neuroblastoma cells. Amer. J. Physiol., 256: C1207-C1213.*
4) *Shonat, R.D., Wilson, D.F., Riva, C.E., and Pawlowski, M. (1992) Oxygen distribution in the retinal and choroidal vessels of the cat as measured by a new phosphorescence imaging method. Applied Optics 31, 3711-3718.*
5) *Vinogradov, S.A. and Wilson, D.F. (1995) Metallotetrabenzoporphyrins. New phosphorescent probes for oxygen measurements. J. Chem. Soc. Perkin Trans. II, 2, 103-111.*
6) *Vinogradov, S.A., Lo, L.-W., Jenkins, W.T., Evans, S.M., Koch, C., and Wilson, D.F. (1996) Non invasive imaging of the distribution of oxygen in tissue in vivo using near infrared phosphors. Biophys. J. 70, 1609-1617.*
7) *Lo, L.-W., Koch, C.J., and Wilson, D.F., (1996) Calibration of oxygen dependent quenching of the phosphorescence of Pd-meso-tetra (4-carboxyphenyl) porphine: a phosphor with general application for measuring oxygen concentration in biological systems. Analy. Biochem. 236, 153-160.*
8) *Lo, L.-W., Vinogradov, S.A., Koch, C.J., and Wilson, D.F. A new, water soluble, phosphor for oxygen measurements in vivo. Adv. Exptl. Med. Biol. 428, 651-656, 1997.*
9) *Vinogradov, S.A., Lo, L.-W., and Wilson, D.F., (1999) Dendritic polyglutamic porphyrins: probing porphyrin protection by oxygen dependent quenching of phosphorescence. Chem. Europ. J., 5 (4), 1388-1347.*

Selected Application Reports: (selected from more than 60)

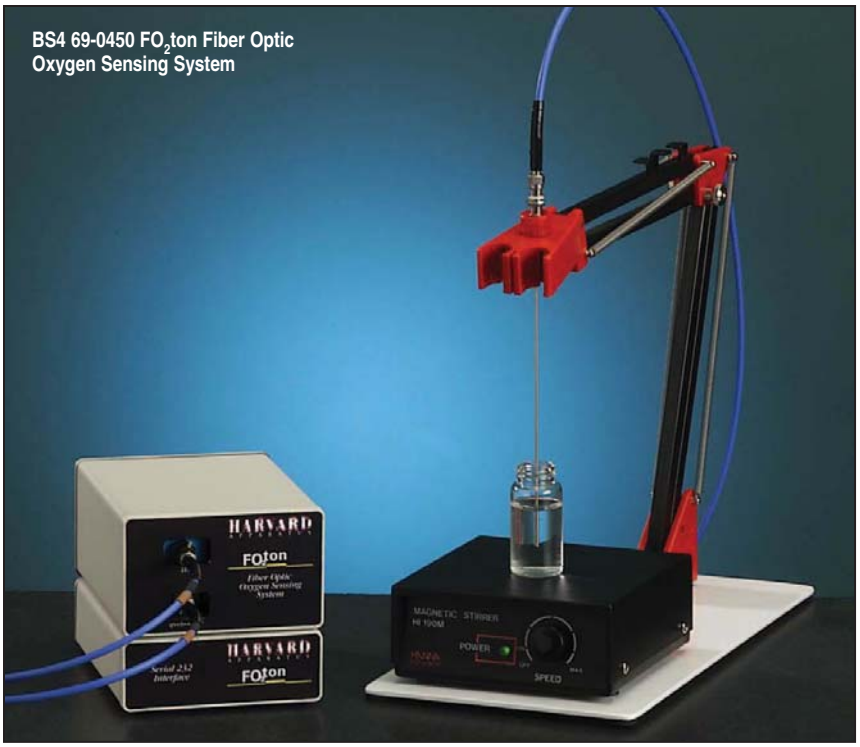
1) *Yonetani, M., Huang, Ch-Ch., Lajevardi, N., Pastuszko, A., Delivoria-Papadopoulos, M.,and Wilson, D.F. (1994) Effect of hemorrhagic hypotension on extracellular level of dopamine, cortical oxygen pressure and blood flow in brain of newborn piglets. Neuroscience Letters, 180, 247-252.*
2) *Rumsey, W.L., Pawlowski, M., Lejavardi, N., and Wilson, D.F. (1994) Oxygen pressure distribution in the heart in vivo and evaluation of the ischemic "border zone". Am. J. Physiol. 266: H1676-1680.*
3) *Huang, Ch-Ch., Yonetani, M., Lajevardi, N., Delivoria-Papadopoulos, M., Pastuszko, A. and Wilson D.F. (1995) Comparison of post-asphyxial resuscitation with 100% and 21% oxygen on striatal dopamine metabolism in newborn piglets. J. Neurochemistry, 64, 292-298.*
4) *Song, D., Olano, M., Wilson, D.F., Pastuszko, A., Tammela, O., Nbo, K., and Shorr, R.G.L. (1995) Comparison of the efficacy of blood and polyethylene glycol-hemoglobin in recovery of newborn piglets from hemorrhagic hypotension: effect on blood pressure, cortical oxygen, and extracellular dopamine in the brain. Transfusion 35, 552-558.*
5) *Poole, D.C., Wagner, P.D., and Wilson, D.F. (1995) Diaphragm microvascular plasma PO_2 measured in vivo. J.Appl. Physiol. 79(6), 2050-2057.*
6) *Olano, M., Song, D., Murphy, S., Wilson, D.F., and Pastuszko, A. (1995) Relationships of dopamine, cortical oxygen pressure, and hydroxyl radicals in brain of newborn piglets during hypoxia and posthypoxic recovery. J. Neurochem. 65, 1205-1212.*
7) *Cerniglia, G.J., Wilson, D.F., Pawlowski, M., Vinogradov, S.A., and Biaglow, J. (1997) Intravascular oxygen distribution in subcutaneous 9L tumors and radiation sensitivity. J.Appl. Physiol. 82(6), 1939-1945.*
8) *Rumsey, W.R., Abbott, B., Lo, L.-W., Vinogradov, S.A., and Wilson, D.F. (1997) Imaging of oxygen in the surface and deep areas of the kidney. Adv. Exptl. Med. Biol. 411: 591-596.*

Specifications

Detection Range	Air Saturation to < 0.1 Torr
Sensitivity	1 part in 10^3
Temporal Resolution	Minimum 20 msec with measurements repeatable each 1.2 sec
Temperature Dependence	Approximately 3% per degree Celsius
Power	Wall Transformer 100/230 VAC, 50/60 Hz
Dimensions	26 x 33.7 x 14 cm (10.25 x 13.25 x 5.5 in)
Weight	5 kg (11 lbs)

Catalog No.	$	Product
BS4 69-0502		PMOD-2000 Phosphorescence Oxygen Measurement System
BS4 69-0503		Cool Color Lamp, Amber (592 nm maximal intensity), 115 VAC, 60 Hz
BS4 69-0504		Cool Color Lamp, Amber (592 nm maximal intensity), 230 VAC, 50 Hz
BS4 69-0505		Cool Color Lamp, Red (638 nm maximal intensity), 115 VAC, 60 Hz
BS4 69-0506		Cool Color Lamp, Red (638 nm maximal intensity), 230 VAC, 50 Hz
BS4 69-0507		Cool Color Lamp, Green (524 nm maximal intensity), 115 VAC, 60 Hz
BS4 69-0508		Cool Color Lamp, Green (524 nm maximal intensity), 230 VAC, 50 Hz
BS4 69-0509		Phosphor, Pd-meso-tetra (4-carboxyphenyl) porphyrin, 1 gm Vial (Oxyphor RO)
BS4 69-0510		Phosphor, Pd-meso-tetra (4-carboxyphenyl) porphyrin dendrimer, 1 gm Vial (Oxyphor R2)
BS4 69-0511		Phosphor, Pd-tetra (4-carboxyphenyl) tetrabenzoporphyrin dendrimer (Oxyphor G2), 20 mg
BS4 72-6180		Phosphor, Pd-tetra (4-carboxyphenyl) tetrabenzoporphyrin dendrimer (Oxyphor G2), 50 mg
BS4 72-6181		Phosphor, Pd-tetra (4-carboxyphenyl) tetrabenzoporphyrin dendrimer (Oxyphor G2), 100 mg

FO_2ton



- Oxygen sensing based on Ruthenium fluorescence detection and fiber optic technology
- Does not consume oxygen, allowing for continuous contact with the sample
- Wide variety of fiber optic sensors sizes available
- Compact system combines a high-sensitivity spectrophotometer, computer interface (USB) and FO_2ton Windows™ 98/NT compatible software
- Small size and 12 VDC power makes it ideal for portable and field use
- Frequently asked questions sheet available

The FO_2ton oxygen sensing system detects oxygen (pO_2) in both solutions or in air through the use of a ruthenium fluorescence and Fiber Optic Technology. The FO_2ton system offers high sensitivity, reversability and stability in the detection of oxygen in numerous applications. Its low power requirements and small package size makes it ideal for remote monitoring, field applications, and other applications where size and/or portability are required.

The thin film ruthenium technology used in the probe tips for detecting oxygen does not consume oxygen, allowing the sensor tip to be in continuous contact with the sample. FO_2ton Oxygen Sensors work in various sample types including viscous samples. Since this technology is immune to interference caused by pH or salinity change or from changes in ionic strength, they can be used in a wide range of experiments. The sensors are designed to have a high resistance to bio fouling. Temperature compensation via an external temperature probe provides added accuracy and stability to the measurement of oxygen is samples were temperature may vary.

The FO_2ton Fiber Optic Oxygen Sensing System uses the fluorescence of an organic ruthenium based dye to measure the absolute concentration of oxygen: Optical fiber carries excitation light produced by an integrated blue LED light source to the thin-film ruthenium dye coating at the fiber optic probe tip. Fluorescence generated at the tip is collected by the probe and carried back by the fiber to a high sensitivity spectrometer. When oxygen in the gas or liquid sample diffuses into the thin-film ruthenium coating, the fluorescence is quenched. The degree of quenching correlates to the concentration of oxygen. Ruthenium tipped sensors are available in different sizes and styles of fiber optic sensors to meet a number of application.

The FO^2ton Fiber Optic Oxygen Sensing System consists of a high-sensitivity miniature fiber optic spectrophotometer, light source, USB interface to connect the system to an IBM compatible benchtop or portable computer and a selection of various size probes. With this combination, a full spectral analysis of dissolved and gaseous oxygen concentration can be achieved.

The high-sensitivity fiber optic spectrometer can be used in a stand-alone mode to measure fluorescence, absorbance, reflectance and radiance, and other types of standard spectrometric measurements through the use of optional fiber optic accessories. Please call our Technical Sales Department for details.

Is the probe influenced by ambient light?

The probe will be affected by ambient light. All probe types should be shielded from ambient light by installation in a closed vessel, or by shielding the probe with a dark housing. Our FOXY-T1000 probe has a screw-on cap to block the optical field of view of the fiber, while allowing easy access to the probe tip.

An overcoat of silicone can be applied to the probe (at no charge) to help reduce ambient light effects. The overcoat slows the response of the probe to 30-50 seconds in liquids and 20-30 seconds in gases.

Did you know?

Harvard Apparatus now owns the Navicyte line of Ussing and Diffusion Chambers. See pages M166 to M170 for complete details on those products and many others.

FO_2ton Fiber Optic Oxygen Sensing System

Specifications

State	Dissolved Oxygen	Gaseous Oxygen
S/W Display	(%, mmHg, ppm)	(%, mmHg, ppm)
Minimum Detectable Limits	0.44 mmHg (0.023 ppm)	0.44 mmHg (0.06%)
Dynamic Range	0 to saturation level*	0 to 100%
Resolution	0.11 to 0.37 mmHg for dissolved oxygen partial pressure 0 to 160 mmHg gas	0.015 to 0.045 % (0.11 to 0.37 mmHg) for oxygen partial pressure 0 to 160 mmHg
Interference	No interference from pH change or salinity	No interference from CH_4, acetone, moisture or CO_2
Resolution:		
High O_2 Concentration	0.02 ppm	0.4%
Low O_2 Concentration	0.003 ppm	0.01%
Stability Drift	< 0.02 ppm per day	< 0.05% per day
Response Time	< 1 sec (< 30 seconds with silicone overcoat)	< 1 sec (< 30 sec with silicone overcoat)
Compensation	For temperature only	For temperature only
Calibration	2 point calibration. First point in oxygen free gas or liquid, second point in air or air saturated water, or liquid	
Effect of Error in	1% error in reading of 0 concentration standard = 1.6 mmHg error in low DO concentration, 0 mmHg error in high end	
Calibration on Answers	1% error in reading of high concentration standard = 4 mmHg error in high concentration, 0 mmHg error in low end	
Replaceable Probe	Yes	Yes
Probe Reconditioning	Yes	Yes
Re-Calibration	Only when probe is replaced	Only when probe is replaced
Probe Temperature Range	-80° to 80°C (110˚C briefly)	-80° to 80°C (110˚C briefly)
Storage Conditions	No specific requirements	No specific requirements
Probe Lifetime	~1 year	~1 year
Chemical Compatibility	1) Unaffected by pH<10 or salinity changes	
	2) Safe with 50% methanol, hexane, CH4, sodium sulfite, acids	
	3) Not recommended with strong bases (pH>10), ethanol, acetone, acetonitrile and HF and BTEX solvents	

** 160 mmHg or 8.4 ppm for water saturated with air, 760 mmHg or 41 ppm at 25°C for water saturated with oxygen, > 760 mmHg for water supersaturated with oxygen.*

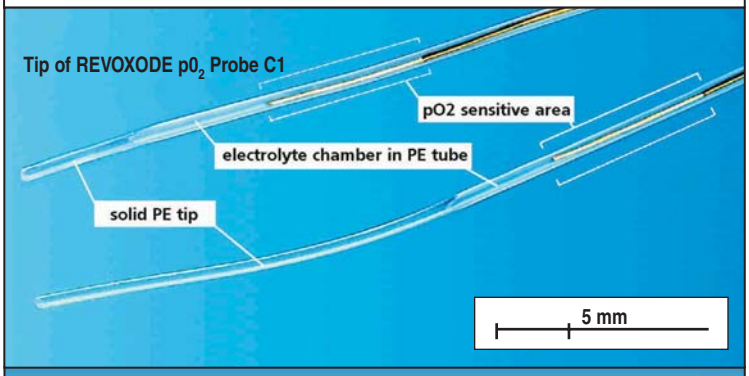
Catalog No.	$	Product
BS4 69-0479		FO_2ton Fiber Optic Oxygen Sensing System, 115/230 VAC, 50/60 HZ
Replacement Parts		
BS4 69-0452		Fiber Optic Oxygen Probe Stainless Steel Probe, 1000 µm core D
BS4 69-0458		Bifurcated Optical Fiber Assembly, 600 µm
BS4 69-0459		Splice Bushing
BS4 69-0463		Temperature Sensor
BS4 69-0464		Fiber Optic Spectrometer for Fluorescence
BS4 69-0465		Blue Light Source for USB F.O. SP
BS4 69-0476		OOI Sensors SW-O_2 & PH Anal, 32 BIT
BS4 69-0477		Factory Calibration SVC for FOXY Sensors
Accessory Parts		
BS4 69-0453		Fiber Optic Oxygen Probe Polyimide Probe, 600 µm core D
BS4 69-0454		Fiber Optic Oxygen Probe, Aluminum Probe, 500 µm OD
BS4 69-0455		Fiber Optic Oxygen Probe, Rugged 1 µm D Silica-Core Fiber in 0.25 in OD Stainless Steel Ferrule, with Screw-On Light Shield
BS4 69-0456		Bifurcated Optical Fiber Assembly, 200 µm
BS4 69-0457		Bifurcated Optical Fiber Assembly, 400 µm

Did you know?

Harvard Apparatus owns Hugo Sachs Elektronik. The HSE isolated organ baths set the industry standard. They can be found in the Isolated Organ and Tissue Section K.

LICOX *MCB*® Universal Oxygen and Temperature Monitor

Rear Panel of LICOX MCB®



BS4 69-0188 Calibration Device for REVOXODE

Probes are usually calibrated within humid chamber in protection cover which is delivered with sterile probe. Cover is inserted into BS4 69-0188 calibration device. This is not required for BS4 69-0201 REVOXODE because temperature probe can be directly inserted (sterile) into oxygen probe.

- Used to measure oxygen partial pressure (pO_2) in gases, fluids, suspensions and biological media
- Determination of saturation or pressure of dissolved oxygen in fluid
- Small, battery operated and water resistant
- Ideal for:
  - — Cell culture media for controlling microbial growth conditions in science and pharmaceutical industry
  - — Living tissue and body fluids for biomedical research and veterinary medicine
  - — Plants, fruits and meat for food science and technology
  - — Mud, silt and soil for toxicological and environmental monitoring

The LICOX *MCB*® is made for oxygen measurements with the flexible REVOXODE catheter micro probes. The temperature is compensated by thermocouple microprobes that have a built-in flexible polyethylene or metal tube for more than one year of use. Every probe is delivered sterile and can be easily calibrated within its sterile protection cover.

For measurements with LICOX *MCB*® a REVOXODE oxygen probe and a type-K thermocouple are simultaneously used. Temperature and oxygen are displayed on LCD, illuminated in the dark; the analog outputs can be used for recording the data with the data collection system LICOX *DAQ*® or a paper chart recorder. The REVOXODE probe is a new electrochemically reversible type of a polarographic microprobe. It has a built in flexible polyethylene tube allowing for over 120 hours of continuous use. The probe is remarkably accurate in long term use, in particular, at low oxygen levels. In the oxygen circuit of LICOX *MCB*® the temperature is specifically compensated for REVOXODE probes.

The oxygen display of LICOX *MCB*® is calibrated by amplifier gain adjustment while the probes are exposed to the reference atmosphere or fluid. Thus the display can be adjusted to absolute pO_2 values in mmHg or hPa (if the pO_2 of the calibration chamber is calculated from a formula given in the instruction manual) or to relative values where the oxygenation in the calibration chamber is set as 100%. The LICOX *MCB*® system includes BS4 69-0189 and BS4 69-0190 probe cables, BS4 69-0197 and BS4 69-0198 output cables, BS4 69-0185, BS4 69-0186 or BS4 69-0187 power supply, BS4 69-0183 rechargeable batteries and BS4 69-0201 probe.

LICOX *MCB*® Universal Oxygen and Temperature Monitor

Specifications

Classification	Lab equipment, CE, electrical safety meets IEC 61010-1, EMI: 61000-4 part 2 to 6, EN 50204, EME: EN 55011
Principle	Polarographic oxygen probe circuit with temperature compensation and type-K thermocouple amplifier
Probe Input	0 to 10,000 nA (oxygen), 1 to 8 mV (temperature), both circuits isolation amplifiers, breakdown voltage > 1.5 kV
Display:	
Oxygen Range	**1.** 0 to 199.9 (mmHg, kPa or %) **2.** 0 to 1999 (mmHg, hPa or %)
Temperature	-199.9 to +199.9, useful range -40°C to 199°C
Analog Signal Output:	
Oxygen	0 to 5 V, 5 mV/display unit
Temperature	-0.4 to 2 V, 10 mV/°C
Calibration	Adjustment of amplifier gain to sensitivity of REVOXODE when placed in humid chamber of known temperature and known (or reference) oxygen content; offset calibration not required for REVOXODE; calibration of temperature channel and probe by manufacturer
Accuracy and Reproducibility:	Values determined if using probes BS4 69-0201 and BS4 65-0426 in pO_2 range of 0 to 150 mmHg at probe temperatures between 15°C and 48°C and at instrument temperatures between 15°C and 30°C
Oxygen Channel	Offset < 1 mmHg, offset drift < 1 mmHg / 120 hr Probe sensitivity drift < 5% / 24 hr and < 10% / 120 hr Temperature compensation error < 5% Linearity error < 2 mmHg
Temperature Channel	Absolute error < 0.5°C
Power Supply	9 V DC, max 700 mA during fast battery charging, EU and UK: 240 VAC 50 Hz, USA: 110 VAC 50/60 Hz
Case Dimensions, H x W x D	Water protected metal case IP64, 3 x 11 x 24 cm (1.2 x 4.3 x 9.5 in)
Case Weight (Net	750 g (26.5 oz), net

Catalog No.	$	Product
BS4 69-0180		LICOX *MCB*® Oxygen Monitoring System, 115 VAC, USA
BS4 69-0181		LICOX *MCB*® Oxygen Monitoring System, 230 VAC, Europe
BS4 69-0182		LICOX *MCB*® Oxygen Monitoring System, 230 VAC, UK
BS4 69-0183		Rechargeable NiMH Batteries, pkg. of 4
BS4 69-0184		Tough Protection Pouch for Outdoor Measurement; Hand Made Real Leather Bag with Front Panel Flap, Accessory Pocket, Cable Protection and Strap
BS4 69-0187		Power Supply, USA, 110 VAC, 40/60 Hz
BS4 69-0185		Power Supply, Europe, 240 VAC, 40/60 Hz
BS4 69-0186		Power Supply, UK, 240 VAC, 40/60 Hz
BS4 69-0188		Calibration Device for REVOXODE Oxygen Probes, Double Metal Barrel with Temperature Sensor (Not required if using BS4 69-0201 Probe)
BS4 69-0189		Oxygen Probe Cable, Blue 2.2 m (7.2 ft)
BS4 69-0190		Temperature Probe Cable, Green 2.2 m (7.2 ft)
BS4 69-0191		Extension Cable for O_2 Probe, Blue 1.5 m (4.9 ft)
BS4 69-0192		Extension Cable for Temp. Probe, Green 1.5 m (4.9 ft)
BS4 69-0195		Analog O_2 Signal Output Cable with BNC Plug
BS4 69-0196		Analog Temp. Signal Output Cable with BNC Plug
BS4 69-0197		Analog O_2 Signal Output Cable with 4 mm Plugs
BS4 69-0198		Analog Temp. Signal Output Cable with 4 mm Plugs
BS4 65-0445		pO_2 Probe Offset Test Kit, 1 Glass Capillary with 10 Ampoules pO_2 Zero Solution

LICOX MCB® Oxygen and Temperature Probes

Cat. No.	$	Model	Length of Sensitive Tip Area	Distance from Tip to Sensitive Area	Ø of Catheter Near to Tip	Ø of Catheter Near to Root	Probe Length	Probe Description
REVOXODE Oxygen Probes								
BS4 65-0415		C1	5 mm	7 mm	< 0.46 mm	< 0.6 mm	200 mm	Standard Use
BS4 65-0418		C1.R	1 mm	2 mm	< 0.46 mm	< 0.6 mm	200 mm	Short Tip, High Resolution
BS4 65-0416		C1.1	5 mm	7 mm	< 0.46 mm	< 0.6 mm	300 mm	Standard Use, Long
BS4 69-0199		C1.G2	7 mm	5 mm	< 0.8 mm	0.8 mm	460 mm	Long and Very Robust
BS4 69-0200		C1.SB	5 mm	5 mm	< 0.65 mm	0.95 mm	150 mm	PE Tube, 3 cm Steel Tube Shaft
BS4 69-0201		C1.G3	4 mm	5 mm	< 0.8 mm	0.8 mm	330 mm	Y-Connector for Thermocouple
Thermocouple Temperature Probe								
BS4 69-0202		C8.B	3 mm	4 mm	< 0.8 mm	0.8 mm	126 mm	PE Tube, 3 cm Steel Shaft

For further information on the use of LICOX for experimental biomedical research in brain, cerebrospinal fluid, muscle, connective tissue, myocardium, tumors, gut, liver and other internal organs please contact Harvard Apparatus Customer Service.

Harvard/Instech Biological Oxygen Monitoring Systems

BS4 61-0130 Dual Chamber Oxygen Monitoring System shown with Stronghold™ stand and clamps (not included, see pages O22–O27)

Dual Chamber Oxygen Measuring System

The BS4 61-0130 is a complete, flexible system designed for oxygen measurement in small samples, as is frequently required in biological research. The system is designed around our miniature Clark-style polarographic electrode. Measuring only 1/8 of an inch in diameter (3.2 mm), it is ideal for metabolic studies of mitochondria, cell suspensions, and enzyme assays. This system includes everything you need for oxygen measurement on two independent channels: a dual channel amplifier, two oxygen electrodes, and two chamber systems. It also includes accessories to simplify electrode maintenance. The chambers can be set up in two basic configurations:

Flow Cell Mode

For in-line measurement of oxygen in solutions flowing past the electrode. This set-up is often used to measure oxygen uptake of perfused tissues by measuring inflow pO_2 with one channel, and comparing it with the outflow pO_2 as measured by the second channel.

Batch Cell Mode

For measuring oxygen consumption in a sealed 600 µl sample. The batch cell chamber includes a magnetically-coupled stirring system, connections for circulating water to maintain a constant temperature, and a unique window-valve for filling, rinsing, or injecting solutions into the chamber. For continuous flow of water use our 66/77 Peristaltic Pumps, see section A.

- Sample sizes as small as 600 µl
- Ideal for biological applications
- Measures oxygen inline or in sealed sample

Catalog No.	$	Component
BS4 61-0130		Dual Chamber Oxygen Measuring System
System Components		
BS4 56-5077		Dual-Channel Amplifier, qty. of 1
BS4 56-5002		Standard Oxygen Electrodes, qty. of 2
BS4 56-4930		Batch/Flow Chamber Systems, qty. of 2
BS4 61-0249		Magnetic Stirring Kits, qty. of 2
BS4 61-0248		Dual-Channel Stirring Controller, qty. of 1
BS4 61-0138		Chlorider and Accessory Kit, qty. of 1
BS4 56-5028		Electrode Accessory Kit, qty. of 1

Components of BS4 61-0130 Dual Chamber Oxygen Monitoring System

Oxygen Electrodes

Our Clark style polarographic electrode measures 41.3 mm (1.625 in) long by 3.2 mm (0.125 in) diameter. The cathode is an exposed section of 0.1 mm (0.005 in) pure platinum wire in a fused glass seal.

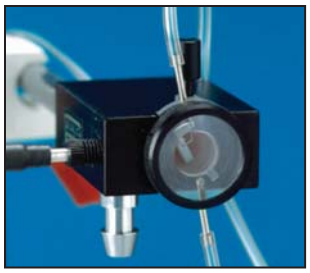
To prepare the electrode, a sheet of polyethylene membrane material is sealed with an O-ring over a drop of KCl solution on the electrode tip. The temperature coefficient is 4%/1°C, so temperature stability in your system is important.

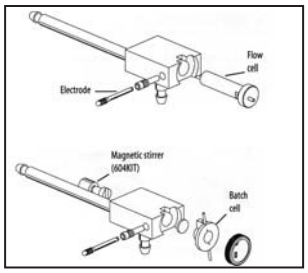
Each electrode includes a cable which is attached to the electrode and sealed to prevent salt contamination, a sleeve to use the electrode in our chamber system, a sleeve to use the electrode outside the chamber, extra membrane material and o-rings, a membrane installation tool, and polishing paper and Scotch-Brite for maintaining the electrode.

This electrode is compatible with the BS4 56-5077 amplifier and YSI's model 5300 oxygen monitor (the cables are different, so specify the appropriate part number). We also supply a special Thurman-style electrode for existing liver perfusion set-ups.

Catalog No.	$	Product
BS4 56-5002		Standard Electrode with Cable
BS4 61-0134		Standard Electrode with YSI Cable (Replaces YSI Part Numbers 5357 and 5358)
BS4 61-0136		Thurman Style Electrode

Harvard/Instech Biological Oxygen Monitoring Systems





Batch/Flow Chamber System

Each chamber system consists of an anodized aluminum chamber block with connections for circulating water to keep the electrode and sample at a constant temperature. The chamber can be set up for oxygen measurement in a fixed 600 µl sample by inserting the Kel-F batch cell cup into the chamber block. The batch cell chamber has separate ports for filling, overflow, and additions made with a micropipette or syringe. A magnetic stirring assembly couples with a 2 x 7 mm stir bar in the cup to keep fresh solution moving past the electrode tip. Alternatively, the chamber can be set up for in-line oxygen measurement by inserting the appropriate flow cell into the chamber block. Separate high and low flow cells cover a range of flow rates.

Catalog No.	$	Product
BS4 56-4930		Chamber Block with Batch and Flow Cells*
BS4 61-0137		Chamber Block with Flow Cells Only*

** Note: Electrode, stirring assembly and stirring controller not included. If needed, order separately, or order part number BS4 61-0131 Instech Oxygen Electrodes.*

Single Chamber Systems with Electrodes

For customers that already have an amplifier, we offer the following.

Catalog No.	$	Product
BS4 61-0131		Batch/Flow Chamber System for Instech Amplifiers
BS4 61-0132		Batch/Flow Chamber System for YSI Amplifiers: BS4 61-0134 Standard Electrode with YSI Compatible Cable
BS4 61-0133		Batch/Flow Chamber System for Diamond General Chemical Microsensor: BS4 61-0135 Standard Electrode with Diamond General Compatible Cable

Dual-Channel Oxygen Amplifier

This amplifier generates the potential that operates our standard electrodes BS4 56-5002 and also converts the nanoamp electrode current into a voltage to measure pO_2. It contains two independent channels, each with gain and zero offset controls and analog outputs. A 3.5-digit LED display can be set with a selector switch to display either channel or the difference between the two. The amplifier measures, H x W x D, 10.8 x 26.7 x 22.2 cm (4.25 x 10.5 x 8.75 in) and weighs 1.6 kg (3.5 lbs). It operates on 120 V AC current, but can set for 220 V operation at the factory.

Catalog No.	$	Product
BS4 56-5077		Dual Channel Oxygen Amplifier

Electrode Chlorider

Our chlorider simplifies the process of electrically depositing a new layer of Ag-AgCl on the pure silver tip of our electrodes. This layer can become contaminated and will wear off under normal operating conditions. To rechloride an electrode, simply fill the stainless steel cup with KCl solution and dip the electrode. The chlorider also includes extra electrode O-rings, an O-ring installation tool, and various polishing papers.

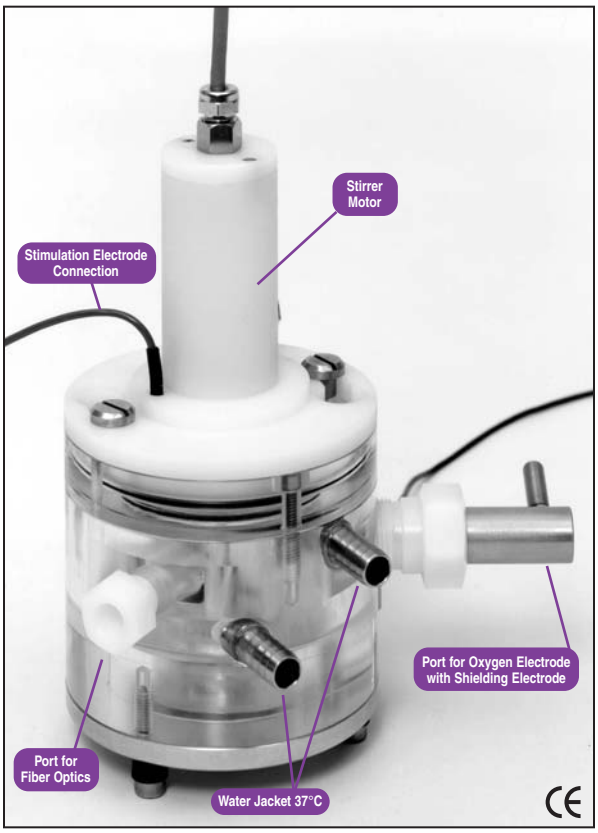
Catalog No.	$	Product
BS4 61-0138		Chlorider and Accessory Kit
Oxygen System Replacement Parts		
BS4 61-0249		Miniature Magnetically Coupled Stirring Kit: Compatible with BS4 56-4930 Batch Cell Chamber, controlled by any Instech Stirring Controller; Includes 12 mm Motor Assembly, Mounting Clip and Teflon Stirring Bar
BS4 56-5028		Accessory Kit for Electrode Maintenance: Includes 15 O-Rings, O-Ring Installation Tool, 24 in^2 Polishing Paper, 24 in^2 Scotch Brite and 72 in^2 Membrane Material
BS4 56-5036		Electrode Cable, 107 cm (42 in), for Instech Amplifiers
BS4 61-0139		Electrode Cable, 107 cm (42 in), for YSI Amplifiers (Replaces YSI 5358)
BS4 61-0140		Output Cable, 107 cm (42 in), for Instech Amplifiers
BS4 61-0250		Teflon Stirring Bars, 2 x 7 mm, pkg. of 3

Precision Stirring Controllers

Our BS4 61-0247 and BS4 61-0248 Stirring Controllers are used to control the magnetic stirring assembly in the batch cell chamber. Each controller has an on/off switch, a power on LED, and a dial to precisely regulate the motor speed from 200 to 5000 RPM. The controllers use a unique 'pseudo tachometer' feedback circuit which reduces electromagnetic interference. The BS4 61-0248 dual channel is a lower cost per channel option than the BS4 61-0247. It is also the most frequently ordered model since many oxygen experiments require two channels.

Catalog No.	$	Product
BS4 61-0247		Single Channel Precision Stirring Controller
BS4 61-0248		Dual Channel Precision Stirring Controller

HSE-HA Oxystat System, Type 1000



Connecting ports of the Oxystat chamber, for a working system it must be equipped with a thermostat, the pO_2 measurement electrode, the controller and the pump, optionally with fiber optics. The stimulation electrodes are built in.

Application

The oxygen consumption VO_2 of small cell assemblies (e.g. papillary muscle) or of isolated cells has usually in the past been calculated from the reduction in the oxygen partial pressure (pO_2) in a 'closed system'. By contrast, the HSE-HA Oxystat operates as an 'open system with feedback'. The pO_2 (as the controlled variable) is maintained constant by the addition of solution with known pO_2. VO_2 can be calculated from the volume added and the pO_2. It is an important advantage of the method that the pO_2 is maintained virtually constant during the experiment. In this way the oxygen consumption can be measured under steady-state conditions at accurately defined pO_2 values, while at the same time also measuring metabolic parameters.

- Unique open system with feedback' for measuring oxygen consumption of cells (cardiomyocytes, hepatocytes, endothelial cells)
- Measures down to 0.1 mmHg
- Two operating modes possible:
  - — Closed system oxygen consumption calculated from pO_2 reduction
  - — Open system (measurement at constant pO_2) controlled addition of solution with known pO_2
- Electrical stimulation capabilities
- Fitting for fiber optics for easy Ca^{++} concentration or redox potential

CE
Main Cell Chamber
Chamber Cover with Stirrer and Grid Stimulation Electrode
Lower Inset with Grid Stimulation Electrode and Filter Holder

Main parts of Oxystat System. Lower inset can easily slide out; it receives filter paper and contains lower stimulation electrode. Upper cover is clipped on chamber and contains stirrer with motor and upper stimulation electrode.

HSE-HA Oxystat System, Type 1000

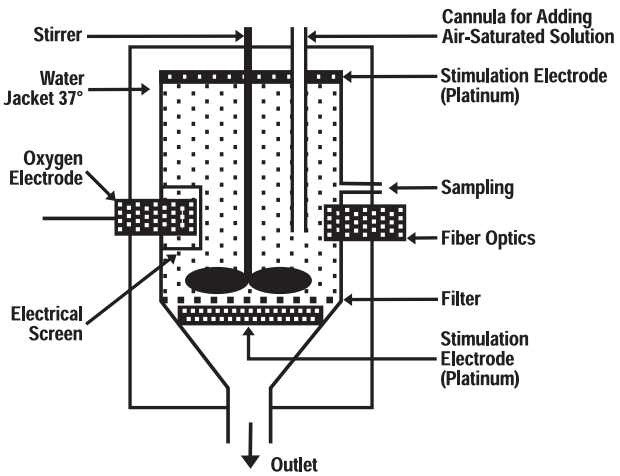


Figure 1: Oxystat Chamber

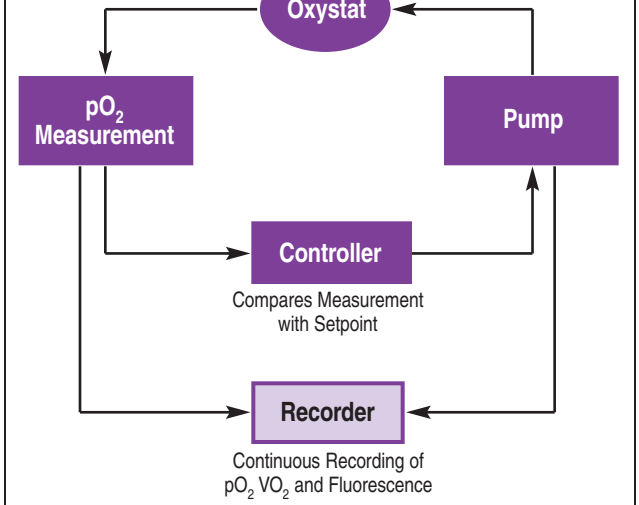


Figure 2: Oxystat System

Oxystat System Components

The Oxystat 1000 System includes the following components:

- Oxystat Incubation Chamber with Stirrer BS4 73-0117
- Power Supply for Stirrer BS4 73-0118 or BS4 73-0119
- pO_2 Electrode BS4 73-0120
- Control Unit Model 719 with amplifier and Pump BS4 73-0122
- Stimulator BS4 73-0124
- Thermocirculator BS4 50-1932 or BS4 50-1940

All of these components must be purchased separately. In addition to the above equipment, a chart recorder or data acquisition will permit recording of data for further analysis. The Oxystat chamber is an incubation chamber with a volume of 10 ml (Figure 1). Mechanical damage to the cells during stirring of cell suspensions was an important disadvantage of previous systems; special attention has therefore been paid here to a very gentle stirring action. The cells are introduced into the chamber and the chamber is filled with medium so as to be free from air bubbles (the venting cannula is used to remove air bubbles from the system). The pO_2 electrode measures the fall in chamber pO_2 due to the oxygen consumed by the cells. Since pO_2 measurement is seriously affected by temperature, the chamber is provided with optimal thermostating.

Operation of the Oxystat

The HSE-HA Oxystat can operate like conventional setups as a 'closed system'. The oxygen consumption is calculated from the slope of the recorded pO_2 reduction. Since the chamber is very well screened against oxygen diffusion it is possible to measure pO_2 down to 0.1 mmHg. The really new application of the Oxystat is however an 'open system' with controlled addition of oxygen through the solution so that O_2 consumption can be measured at constant pO_2.

The operation of the Oxystat as an open system is indicated in Fig. 2. The pO_2 signal is examined by the controller; if it differs from the preset value a pump is operated to introduce oxygen-rich solution into the chamber. This raises the pO_2 in the chamber back to the set value and the pump is then stopped again. As a result a flow equilibrium is established through which, despite the oxygen consumption of the incubated cells, the chamber pO_2 is maintained close to the set value (±5%). The volume in the chamber is maintained constant since the additional volume flows away through an outlet filter. The volume introduced into the Oxystat to maintain the set pO_2 is used to calculate the oxygen consumption of the cells. A cannula permits withdrawal of samples for biochemical analysis without interfering with the measurement of oxygen consumption. As an option there is provision for fitting a fiber optic into the chamber for simultaneous measurement of additional parameters such as intracellular Ca^{++} concentration or redox potential. Two platinum mesh fittings inside the chamber can be used for electrical stimulation of muscle cells to experimentally increase the O_2-consumption. A separate stimulator, see below, is required for this application.

Oxystat Measuring System Model 719

This system includes the Oxystat control unit and the pump. It consists of a titrator connected to the pO_2 meter. The volume is displayed and can be recorded.

Square Wave Stimulator G-270

It has been developed for the stimulation of isolated cardiomyocytes in suspension. The main specifications are:

- Output voltage 50 to 250 V
- Maximum output current 7 A
- Square wave biphasic stimulation pattern
- Stimulation width 10 to 255 µsec
- Stimulation frequency 0.1 to 20.0 Hz

HSE-HA Oxystat System, Type 1000

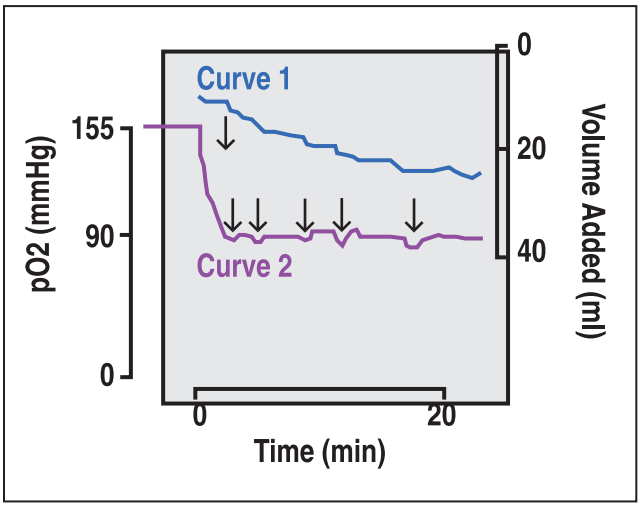


Figure 3: Original recording from incubated isolated cardiomyocytes in Oxystat at available oxygen concentration of 90 mm Hg. Curve 1: added volume; Curve 2: chamber pO_2. Arrows: Instants of sampling for biochemical analysis.

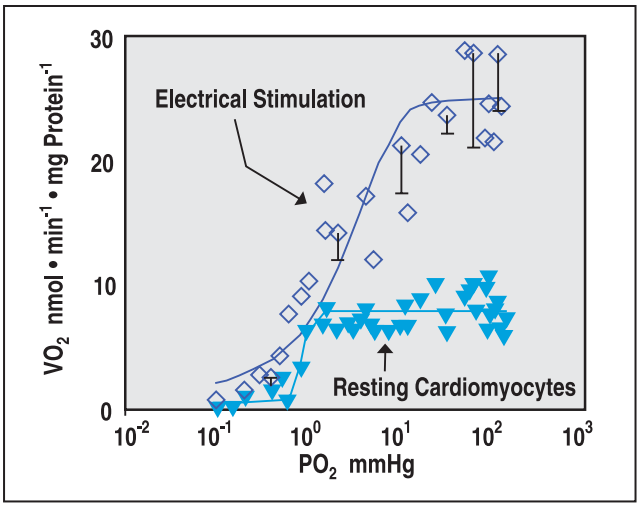


Figure 4: Oxygen consumption (VO_2) of isolated cardiomyocytes at different values of available oxygen.

Typical Recording

Fig. 3 shows an original recording. Isolated cardiomyocytes were incubated at a pO_2 of 90 mm Hg and seven samples were withdrawn consecutively for biochemical analysis. Curve 2 is the record of the pO_2 electrode. The electrode was calibrated with aerated solution (155 mm Hg). After the cells were added, the pO_2 in the chamber drops steeply. When the pO_2 falls below 90 mm Hg the controller starts the pump and aerated solution is added (curve 1) until the pO_2 has returned to its set value. The pump is operated more or less frequently depending on the O_2 consumption of the cells. From the solution volume added in unit time, i.e. the slope of curve 1, it is possible to calculate the oxygen consumption of the isolated cardiomyocytes. After taking the samples (0.8 ml each, arrows) the total quantity of cells in the chamber is reduced and less solution is required in order to maintain the chamber pO_2 at 90 mm Hg. The slope of curve 1 is correspondingly reduced.

Typical Application

The relationship between available oxygen and oxygen consumption of isolated cardiomyocytes has been investigated under different forms of stimulation (Fig. 4). Resting cardiomyocytes (triangles) have a constant oxygen consumption over a wide pO_2 range (1 to 120 mm Hg). It is only below a so-called 'critical pO_2', here at 1 mm Hg, that the oxygen consumption decreases with decreasing available oxygen. Electrical stimulation of the cells at a frequency of 9 Hz produces a 3-fold increase in oxygen consumption (rhombus). Here again the oxygen consumption remains constant over a wide pO_2 range. The critical pO_2 is raised to 10 mm Hg. Below this pO_2 the oxygen consumption decreases with decreasing available oxygen. Using the Oxystat system it could thus be shown that stimulation not only produces an increase in oxygen consumption but also that the critical oxygen value, below which the cells are in oxygen deficit, is displaced towards higher partial O_2 pressures.

References:

1) Stumpe T. and Schrader J.: Phosphorylation potential, adenosine formation, and critical PO2 in stimulated rat cardiomyocytes, Am.J.Physiol. 273, H756-H766, 1997

Oxystat System

For a complete Oxystat System, please order one each of the following components:

BS4 73-0117
BS4 73-0118 or BS4 73-0119
BS4 73-0120
BS4 73-0122
BS4 73-0124
BS4 50-1932 or BS4 50-1940

Catalog No.	$	Product
BS4 73-0117		Oxystat Chamber, Thermostated, Volume 10 ml, with Built-In Stirrer, Requires BS4 73-0118 or BS4 73-0119 Power Supply for Stirrer
BS4 73-0118		Power Supply for Stirrer with Adjustable Voltage, 115 VAC, 60 Hz
BS4 73-0119		Power Supply for Stirrer with Adjustable Voltage, 230 VAC, 50 Hz
BS4 73-0120		PO_2 Electrode Type 2000-100
BS4 73-0122		Oxystat Measuring System Controller Model 719, Includes Controller and to Connect pO_2 Electrode; with Recording Outputs for pO_2, pO_2 Drift and Volume, 115/230 VAC, 60/50 Hz
BS4 73-0124		Square Wave Stimulator G270, for Biphasic Stimulation, 115/230 VAC, 60/50 Hz
BS4 50-1932		Harvard Apparatus Thermocirculator, 115 VAC, 60 Hz
BS4 50-1940		Harvard Apparatus Thermocirculator, 230 VAC, 50 Hz
Optional Accessories		
BS4 72-2987		2-Channel Flatbed Recorder, Economy Version, 250 mm Chart Width
BS4 73-1523		Plugsys Minicase
BS4 73-0210		OPPM Oxygen Partial Pressure Amplifier Module

For the direct detection of oxygen, see page M6.

Precision Dissolved Oxygen Measurement and Respirometry

Strathkelvin Instruments dissolved oxygen respirometry systems are based on ultra precise microcathode oxygen electrodes. The oxygen meters and interfaces are supplied with dedicated respirometry software. A choice of respirometer cells, with volumes from 50 microlitres to 3 ml, are available to meet most biomedical research applications.

NEW 6-Channel Oxygen System Model 928

- For closed chamber respirometry
- Flow respirometry
- Dissolved oxygen monitoring

The 928 is a complete system for replicate measurements of dissolved oxygen, together with data recording and analysis by computer. Use of this system will result in considerable time saving in both respiration experiments and in dissolved oxygen monitoring situations. The system is comprised of a microprocessor-based interface which accepts up to six 1302 microcathode oxygen electrodes, and dedicated Windows software. All operations are controlled from the computer screen, and output of recordings in chart recorder format to a printer is available.

The interface provides the polarizing voltage to the electrodes, amplifies the low-level signals, makes the A/D conversion, and feeds the resulting data stream to the computer. The system is a "virtual instrument" therefore there are no front panel controls. All operations are controlled by the computer. An illuminated front panel display provides information on the activity of the interface and displays readings from the electrodes when they are in use.

The 928 Oxygen System may be used with the Model RC 650 6-electrode Respirometer, see page M21. Details of the software are shown on the facing page. Software included.

Specifications

Resolution with 1302 Electrode	0.1% of air-saturated water
Polarizing Voltage	400-900 mV(anode connected to ground)
Power Requirements	100 to 250 VAC, 50 or 60 Hz
Dimensions	275 x 258 x 117 mm (11 x 11 x 4.5 in)

Catalog No.	$	Model	Product
BS4 69-3000		928	6-Channel Oxygen System

NEW 1-2 Channel Oxygen Meter

- Operates with 1 or 2 oxygen electrodes
- Interfaces to respirometry/monitoring software, or use as stand alone meter
- Use any unit of PO_2 or oxygen concentration
- Closed cell, flow-through respirometry and O_2 monitoring software included

This versatile new Oxygen Meter acts as both a stand alone oxygen meter, displaying and storing oxygen values, or as an interface to respirometry or monitoring software running on a PC. It accepts inputs from either one or two Strathkelvin 1302 microcathode oxygen electrodes, and shows the oxygen values on a large liquid crystal display. The display will show units of either PO_2 (mm Hg; torr; KPa) or concentration (µmol/l; µg/l; mg/l; µl/ml; ml/l; ppm; or % saturation). When connected to the software (supplied, which is installed on a PC, it can be used for either closed cell respirometry (using the MT200 mitocell; RC300 or RC350 respiration cell) or for flow respirometry (using the FC100 flowcell or MC100 microcell). Alternatively the software can be used to monitor dissolved oxygen, as in isolated organ preparations. Details of the software are shown on the facing page. Software included.

Specifications

Resolution	0.01% of full scale
Repeatability	0.01%
Logging Capacity	2000 readings
Computer Interface	USB1
Power Requirements	5V, 1A from external plugtop power supply, 100-230 VAC, 47-63 Hz
Dimensions	185 x 135 x 105 mm (7.25 x 5.25 x 4.125 in)

Catalog No.	$	Model	Product
BS4 69-3001		782	1-2 Channel Oxygen Meter

NEW Respirometry Software

The software used in the 782 meter and the 928 system is essentially similar. The main difference is that the 928 displays up to 6 traces, while the 782 has a maximum of two.

The program has been written so that it is extremely user-friendly and quick to learn. It can be used for closed cell respirometry (with the MT200, RC300, RC350 or RC650), or flow respirometry (using the FC100 or MC100) or for monitoring dissolved oxygen (using the FC 100 or MC100). When used for respirometry experiments, it follows the familiar logical sequences of operations, from electrode calibration to recording and analysis. The program follows a sequence of 3 main stages: Setting up, Recording, and Analysis.

Setup

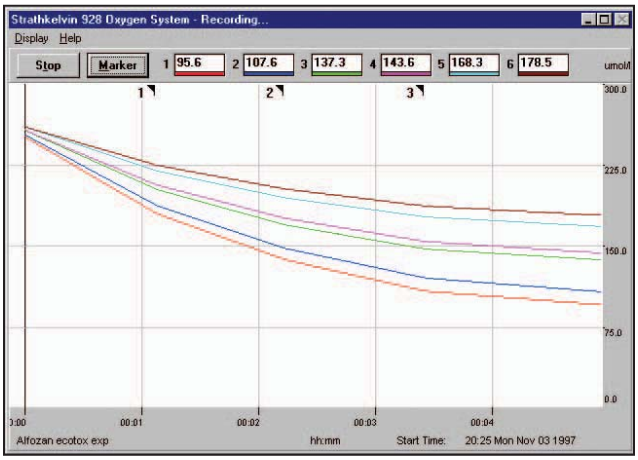
The setup screen is used for entering all of the details which the computer needs in order to record in the correct units, and to express the respiration rate, normalized to biomass units if required, in the desired units. All experimental details entered here are transferred through to the final calculated results report page. During setup, the cell volumes (for closed cell) and flow rate, electrode positioning (for flow respirometry), temperature of the experiment, scrolling speed of the traces during recording, and the instruction to print the recording screen to printer (if hard copy is required) are all entered. Many of these will not change from one experiment to the next, and it is only necessary to enter changes.

Recording

Clicking the 'Start' button initiates the recording process, and traces then scroll across the screen. If substrates, inhibitors or other solutions require to be added during the run, the position where this occurs can be recorded with a flag, and the nature of the addition is recorded on a drop down menu. At the termination of the experiment, the data are saved to a data file, and may be analyzed straight away if required.

Analysis

The data file, recorded traces, and event marker flags are recalled to the screen. If the recording has exceeded one screen width, it can be contracted to fit the screen, if required. Alternatively it is possible to scroll along long recording traces. Selector lines may be dragged to enclose specific parts of the trace. Thus if the traces show both control respiration and changed respiration after adding a solution, the selector lines would be dragged to the control rate first and then to the changed rates.



In each case respiration rates (normalized if so designated) are calculated automatically by clicking the 'Calculate' button. The calculated rates are tabulated, together with the experimental details entered during Setup, on the report page. The results may be exported to a spreadsheet, word processing or statistics package. The Analysis screen and the Report page may be printed, if required.

Traces | Report

Title:	**Alfozan Cytotoxicity**
Date:	Wed Jul 19 2000
Time:	16:21:03
Temp:	37.0°C
Comments:	Effects of 1, 2 & 4 ppm Alfozan, added cumulatively, on BG/625/02
Filename:	C:Strathk\data\Ccelldem.dat

	Biomass (mg)	*Vol.(ml)*
Chamber A:	0.79	2.1
Chamber B:	0.83	2.1
Chamber C:	0.81	2.1
Chamber D:	0.89	2.1

	Start (hh:mm:ss)	Length (hh:mm:ss)	Chamber A Norm Rate (umol/h/mg)	Chamber B Norm Rate (umol/h/mg)	Char Norr (umo
1 No teatment	0:00:41	0:02:06	27.837	26.251	
2 1ppm Alfozan	0:03:12	0:02:02	22.969	21.811	
3 2ppm Alfozan	0:05:35	0:02:31	16.161	15.78	

When the software is used for dissolved oxygen monitoring, the Analysis screen which displays the recorded traces and the oxygen values at flagged points or at set times can be transferred to the Results and report page.

The program requires a computer with a minimum specification of: Pentium processor, 1 free serial port, 64 Mb RAM, Windows 95 or later and 4 MB hard disk space. A comprehensive Instruction Manual is supplied, which will be particularly valuable to anyone who is not familiar with respirometric work.

This software is supplied with the 6-Channel Oxygen System Model 928 and the 1-2 Channel Oxygen Meter. It is not available separately.

NEW Microcathode Oxygen Electrode Model 1302

- May be used with or without stirring the medium
- High stability of output
- Very low rate of oxygen consumption
- Compatibility with all Strathkelvin accessories

This is a Clark-type polarographic electrode with a 22 micron diameter platinum cathode and silver/silver chloride anode connected by a buffered potassium chloride electrolyte solution. In the normal configuration the cathode is covered with a relatively low permeability polypropylene membrane, in order for the electrode to be used in unstirred solutions or where minimal stirring is required. This membrane gives a relatively slow response time. For fast response, as required for rapidly respiring enzyme preparations, a thin FEP membrane (used with a special electrode jacket, (BS4 69-3011) is used. Rapid stirring of the medium is then necessary. The electrodes are not temperature compensated and require controlled temperature environments (within 0.1°C). They should always be used in the electrode holder of one of the Strathkelvin accessories, so that only the tip of the electrode is exposed to the medium.

Specifications

Response Time at 37°C:	
Polypropylene Membranes	c 18 sec for 90% change
FEP Membranes	c 6 sec for 90% change
Oxygen Consumption (Polypropylene Membranes)	c 0.5 - 3.0 x 10^{-10} mg O_2/min
Temperature Coefficient	c 2% per °C

Catalog No.	$	Model	Product
BS4 69-3006		1302	Microcathode Oxygen Electrode
BS4 69-3007		–	Oxygen Electrode Service Kit
BS4 69-3008		–	Electrolyte Solution, 125 ml
BS4 69-3009		–	Polypropylene Membranes, Box of 15
BS4 69-3010		–	FEP Membranes, pkg. of 15
BS4 69-3011		–	Electrode Jacket (with Hole) for FEP Membranes
BS4 69-3012		–	Electrode Jacket (without Hole) for Polypropylene Membranes
BS4 69-3013		–	O-Rings, Box of 25 SI130

NEW Mitocell Miniature Respirometer Model MT200 and MT200A

- Miniature respirometer for mitochondria and cell suspensions
- Integral magnetic stirrer
- Glass chamber with volumes of 50/100 µl (MT200) or 0.3/0.5/1.0 ml (MT200A), and good visibility of contents
- Transparent polycarbonate plunger
- Substrate and inhibitors may be injected directly into chamber

This new Mitocell Miniature Respirometer has a chamber volume of only 50 µl and was introduced for measurements on mitochondria isolated from biopsy samples. It can be used in any situation where sample size is limited. The base section contains an integral solid state, fixed speed magnetic stirrer. The 1302 microcathode electrode (BS4 69-3006) is inserted from beneath the unit, and its projecting tip forms the base of the respirometer chamber. The glass chamber unit is surrounded by a water jacket through which constant temperature water is circulated. The respiration cell has a polycarbonate plunger with a central capillary through which solutions may be added during the course of a respiration run. Stainless steel magnetic spinbars are supplied together with a special 1 µl syringe supplied with MT200 and a 5 µl syringe with the MT200A for solution additions. An alternative version with a large volume (0.3, 0.5 and 1.0 ml) and a PTFE coated stirbar is also available.

Catalog No.	$	Model	Product
BS4 69-3033		MT200	Mitocell Miniature Respirometer, 50/100 µl
BS4 72-6186		MT200A	Mitocell Miniature Respirometer, 0.3/0.5/1.0 ml
BS4 72-6187		SK205	Replacement Glass Plunger for MT200
BS4 72-6188		SK206	Replacement Glass Plunger for MT200A

NEW 6 Electrode Respirometer Model RC 650

- Ability to carry out replicate experiments, utilizing the advanced recording and analysis features of the Strathkelvin\928 system
- Integral unit complete with magnetic stirrer
- Good visibility of cell contents
- Variable cell volume

For use with the 928 6 channel oxygen system - for replicate respiration measurements of cell suspensions, microbial suspensions, mitochondria or enzyme preparations The respirometer consists of a sealed water both containing six respirometer cells located above a six-position magnetic stirrer. Electrode holders, with a hole in their tips through which the membrane of the 1302 electrode protrudes, make a sliding fit into the cells. As the holder is inserted into the preparation, the sloping face at its tip gathers the air into the slot, which runs the complete length of the holder. Respiratory inhibitors or other solutions can be injected directly into the cell via this slot, using a fine bore needle (included). The volume of the cells may be set between 1 and 3 ml, by rotating the knurled collar of the holders. The rear of the bath contains a further 6 cells which are used to park the electrode holders and maintain them at a constant temperature while changing the contents of the respiratory cells. For easy removal and cleaning the cells are sealed into the water bath by O-rings.

Specifications

Diameter of Cells	16 mm
Volume of Cells	1 to 3 ml (adjustable)
Cell	Precision bore glass
Electrode Holder	Black acetal, with peek tip
Bath	Clear and black acrylic
Magnetic Stirrer	6-position; 12 VDC from external plugtop power supply, 100-230 V, 47-63 Hz

Catalog No.	$	Model	Product
BS4 69-3021		RC 650	6 Electrode Respirometer

NEW Respiration Cells RC 300 and RC 350

- Small sample volume
- Good visibility of cell contents

These respiration cells are for small volume measurements of oxygen uptake rate by microbial suspensions, cell suspensions, mitochondria or enzyme preparations. The electrode holder (supplied with the cell) slides into one of two glass tubes fused into the glass water jacket. The second tube is used to park the electrode holder when changing solutions. A fine slot (1 x 1 mm) in the side of the holder allows air to escape when the holder is inserted into the cell. It may also be used to introduce other solutions during the course of a respiration run and a fine bore needle with luer fitting (included). A PTFE covered magnetic spinbar is provided and the cell should be located on a magnetic stirrer unit (not provided). For fast reactions, it is recommended that FEP membranes used with electrode jacket (BS4 69-3011) are used.

Specifications

Model	RC 300	RC 350
Cell Diameter	13 mm	16 mm
Cell Volume	0.3 to 1.0 ml	1.0 to 3.0 ml
Cell	Glass	
Electrode Holder	Black acetal	

Catalog No.	$	Model	Product
BS4 69-3018		RC 300	Respiration Cell
BS4 69-3019		RC 350	Respiration Cell
BS4 69-3027		–	Replacement Glass for BS4 69-3018
BS4 69-3028		–	Replacement Glass for BS4 69-3019
BS4 69-3032		–	Spinal Needles for use with BS4 69-3018 & BS4 69-3019, pkg. of 3

NEW MicroCell Model MC 100

- For pO_2 measurement of blood or other fluids, or for micro flowcell use
- Small Sample Volume
- Flow through or spot measurement
- Exceptional visibility
- Easy acess for cleaning

The all-glass sample chamber has a capacity of approximately 70µl. Samples are injected into the chamber through a 1mm stainless steel tube fitted with a fine p.v.c needle-locating collar. Alternatively, the cell can be used as a micro flowcell by connecting the outflow from a respiring preparation. The sample leaves the chamber through a glass Luer fitting to which a small bore flexible drainage tube can be connected. The sample chamber is completely surrounded by water circulated through the glass water jacket from a constant temperature bath. This provides good temperature regulation while providing excellent visibility of the contents of the chamber. The water jacket screws into an acetal base section and can be easily removed for cleaning. The microcathode electrode fits into the central electrode holder and the membrane at its tip forms the floor of the sample chamber.

Specifications

Sample Chamber	70 µl
Overall Height	106 mm
Jacket and Cell	Glass
Base Section	Black acetal

Catalog No.	$	Model	Product
BS4 69-3016		MC 100	MicroCell Model

NEW Flow Cell FC 100

- For continuous in-line oxygen monitoring or for connection to flow-through respirometer chamber
- Easily disassembled for cleaning
- Good visibility of flowline

The acrylic chamber of the flowcell screws onto the electrode holder. Only the tip of the electrode projects into the water flow. The inlet and outlet tubes are made from stainless steel. The electrode holder is fitted with a collar for attachment to a vertical or horizontal (1/4 to 3/8 inch) diameter laboratory rod to enable the flowcell to be immersed below the surface of the constant temperature bath containing the respirometer chamber.

Specifications

Material:	
Electrode Holder	Black acetal
Collar	Black acetal
Chamber	Clear acrylic
Inlet/Outlet	6 mm OD and 3 mm ID stainless steel

Catalog No.	$	Model	Product
BS4 69-3023		FC 100	Flow Cell

NEW General Electrode Holder EH 100

- For use with any of your own custom respiration chamber designs

The electrode holder is a black acetal tube in which the electrode is located so that its tip projects from the end. The holder is used for the insertion of the electrode into your own respiration chamber. An acrylic collar containing an O-ring on its inside surface is also provided. This can be cemented over a 13mm hole drilled in the wall of the respiration chamber to facilitate insertion of the electrode holder. The electrode should only be used in an electrode holder, to avoid ground- leak damage.

Specifications

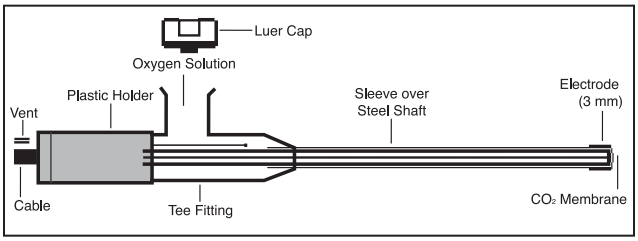
	Electrode Holder	Acrylic Collar
Dimensions	13 x 85 mm (D x L)	26 x 10 mm (D x L)
Holder Material	Black acetal	Clear acetal

Catalog No.	$	Model	Product
BS4 69-3024		EH 100	Electrode Holder

Microminiature CO_2 and pH Electrodes

This series of micro pH, O_2 and CO_2 electrodes has been specifically designed for use in various area of bioscience research. Their microminiature design and small sensing area allows them to be used for small area measurements. This series of pH electrodes have similar response characteristics to standard size, glass pH electrodes making them compatible with any standard pH meter. The pH series of electrodes come in a variety of configurations to fit every need.

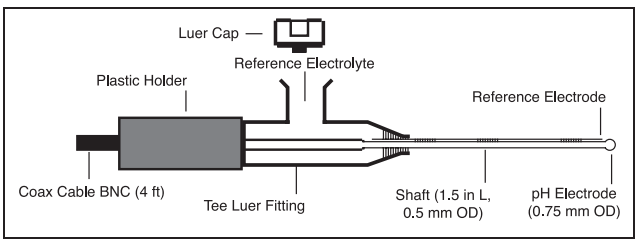
Micro-CO_2 Electrode



This CO_2 electrode is connected to the BNC connector of a standard pH meter by developing a calibration curve % CO_2 vs. mV using the mV mode on the pH meter. The calibrations curve can be generated by using two known concentration standards.

Catalog No.	$	Product
BS4 69-0499		Micro-CO_2 Electrode

Combination pH Electrode for Micro Wells



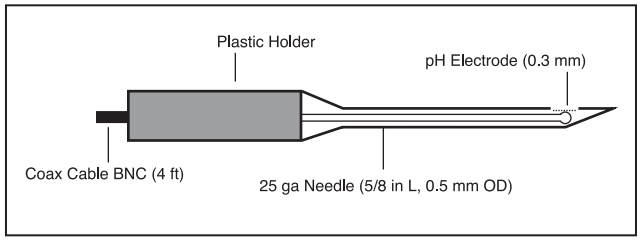
This a miniature combination pH/reference electrode has been designed to fit small perfusion chambers without effecting fluid exchange rates. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Dimensions, L x D	38.1 x 0.75 mm (1.5 x 0.03 in)

Catalog No.	$	Product
BS4 69-0494		Combination pH Electrode for Micro Wells

Single pH Electrode in 25 Gauge Needle



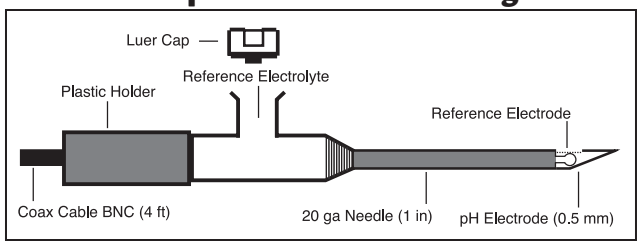
This is a microminiature pH electrode mounted in the lumen of a fine hypodermic needle. This configuration allows for easy penetration and insertion in all types of tissue for on-line/real time monitoring of pH. This pH electrode does not contain an external reference. To use this electrode and external reference electrode such as the BS4 69-0490 or similar reference electrode must be used. The electrode is stored dry.

Specifications

Response Time	~15 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	1500 M Ω
Stability	0.05 pH per day

Catalog No.	$	Product
BS4 69-0491		Single pH Electrode in 25 ga Needle
BS4 69-0490		Flexible Reference Electrode, see page M28.

Combination pH Electrode in 20 Gauge Needle



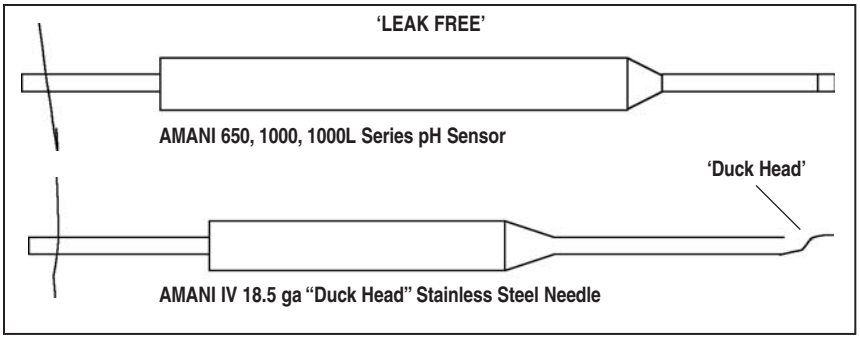
This is a miniature combination pH/reference electrode that is mounted in a 20 gauge, 1 inch x 0.5 mm OD stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet. Tip length is 1.8 mm.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Dimensions, L x D	25.4 x 0.9 mm (1 x 0.035 in)

Catalog No.	$	Product
BS4 69-0493		Combination pH Electrode in 20 ga Needle

AMANI 'LEAK FREE' Microcombination pH Electrodes



The AMANI 'LEAK FREE' series of non-glass, micro pH electrodes are the latest development in our combination (built in reference) pH electrode line. The new technologies used in these electrodes provide superior sensitivity and stability. The 'LEAK FREE' non-porous reference junction eliminates the problems of clogged junction and adsorption of proteins and surfactants. They also have high resistance to chemical including hydrofluoric acid solutions.

With tip diameters starting as low as 650 µm, they are one of the smallest combinations pH electrodes on the market today. The new 'DUCK HEAD' design of the AMANI IV has been developed to offer complete protection for the electrode's tip during insertion without compromising the electrodes performance. The electrode is built into a custom 18.5 ga (1.2 mm) needle and can be used to measure the pH of solid samples such meats, fruits, and vegetables without sample preparation. Custom configurations of the AMANI series of pH combination electrodes are also available, please contact Harvard Apparatus Technical Sales Department for further details.

- Integrated **'LEAK-FREE'** non-porous reference junction eliminating problems of clogged junction and absorption of proteins and surfactants
- All plastic construction, unbreakable and tough — **no glass!**
- Can be used with any pH meter with BNC connector
- 'Zero' depth of immersion, just touch sample to flat tip
- Superior chemical resistant — can be even be used in hydrofluoric acid solutions
- Tip diameter as small as 650 µm including reference electrode
- Standard Nernstian behavior
- Flexible version is available for use in restricted areas such as microscope stage
- Long working life
- Low cost
- Maintenance-free, dry or wet storage, no filling solutions needed

Specifications

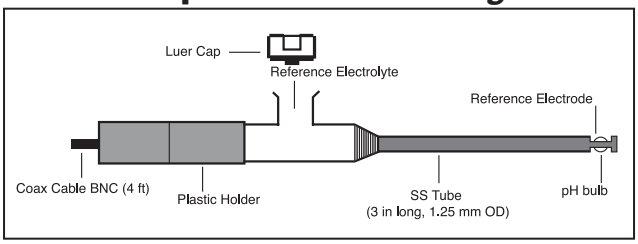
Model	AMANI-650	AMANI-1000	AMANI-1000L	AMANI-IV
Tip Diameter	650 µm	1000 µm	1000 µm	1200 µm
Tip Length	20 mm (0.8 in)	20 mm (0.8 in)	75 mm (3 in)	37 mm (1.5 in)
Construction	All Plastic	All Plastic	All Plastic	Plastic/Stainless Steel
Depth of Immersion	< 100 µm	< 100 µm	< 100 µm	1000 µm
Min. Sample Volume	250 nL	500 nL	500 nL	n/a
Response Time	< 3 sec, 90% response	< 3 sec, 90% response	< 3 sec, 90% response	< 3 sec, 90% response
Temperature Range	0° to 100°C	0° to 100°C	0° to 100°C	0° to 100°C
Internal Reference	Ag/AgCl	Ag/AgCl	Ag/AgCl	Ag/AgCl
Slope	Nernstian	Nernstian	Nernstian	Nernstian
pH Range	0 to 14	0 to 14	0 to 14	0 to 14
Storage	Wet or dry	Wet or dry	Wet or dry	Wet or dry
Connector	BNC	BNC	BNC	BNC
Electrode Holder OD x Length	4.8 x 75 mm (0.19 x 2.9 in)	4.8 x 75 mm (0.19 x 2.9 in)	4.5 x 50 mm (0.18 x 2 in)	4.8 x 50 mm (0.19 x 2 in)
Lead Wire	0.9 m (3 ft)	0.9 m (3 ft)	0.9 m (3 ft)	0.9 m (3 ft)
Catalog No. $	**BS4 69-0020**	**BS4 69-0021**	**BS4 69-0022**	**BS4 69-0019**

Did you know ?

Harvard Apparatus sells a complete line of pH Meters and Magnetic Stirrers. See the General Laboratory Section O or visit our website at www.harvardapparatus.com.

Microminiature pH Electrodes

Combination pH Electrode in 18 Gauge SS Tube



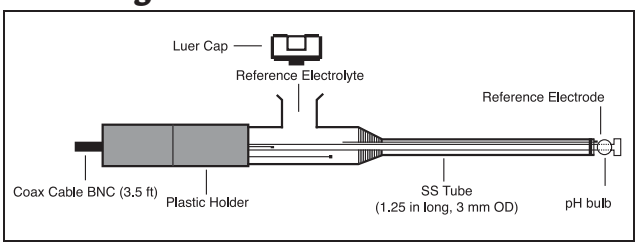
This miniature combination pH/reference electrode is mounted in an 18 gauge, 3 inch x 1.25 mm OD stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet. Tip length is 1.5 mm.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Dimensions, L x D	76 x 1.25 mm (3 x 0.005 in)

Catalog No.	$	Product
BS4 69-0492		Combination pH Electrode in 18 ga SS Tube, Model IC-201

Combination pH Electrode in 11 Gauge SS Tube



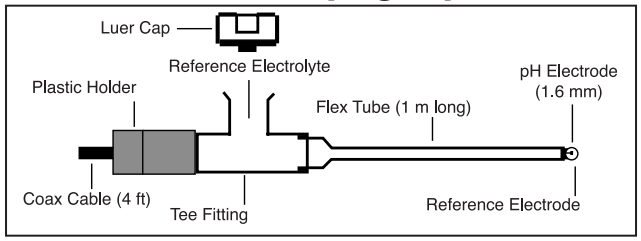
This miniature combination pH/reference electrode is mounted in an 11 gauge 1.25 inch x 3 mm OD stainless steel tube. The stainless steel tube provides protection to damage of the internal miniature glass pH sensor. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Dimensions, L x D	31.7 cm x 3 mm (1.25 x 0.1 in)

Catalog No.	$	Product
BS4 69-0497		Combination pH Electrode in 11 ga SS Tube

Combination Gastroesophageal pH Electrode



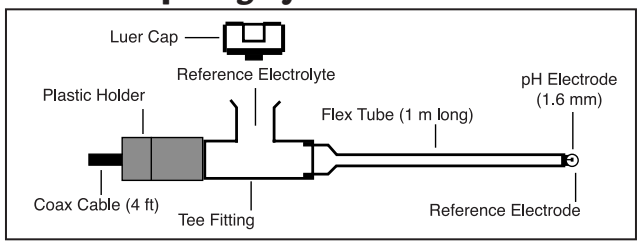
This miniature combination pH/reference electrode has a long 3 foot long flexible tube to fit into the esophagus. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Electrode OD	1.6 mm
Dimensions, L x D	91.4 cm x 1.6 mm (3 ft x 0.06 in)

Catalog No.	$	Product
BS4 69-0495		Combination Gastroesophageal pH Electrode

Flexible Combination pH Electrode for Free Flap Surgery



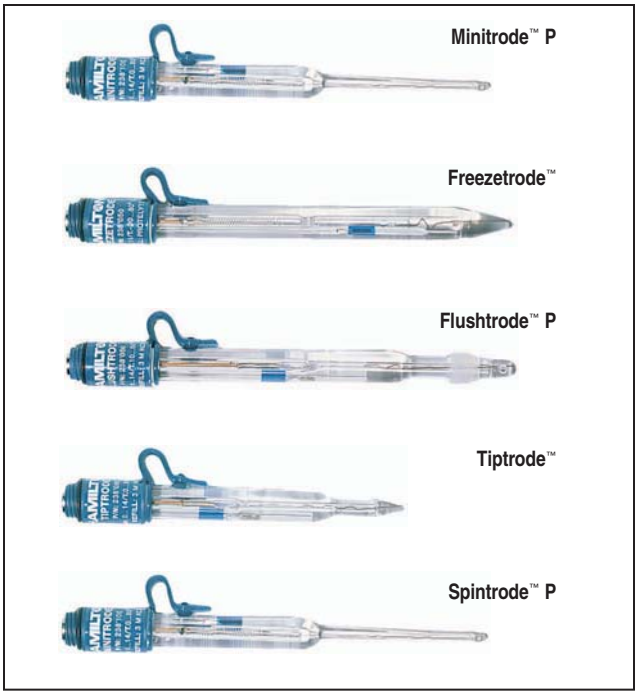
This miniature combination pH/reference electrode has been specifically designed to be used in free flap surgery. It does not require an external reference electrode. The reference solution can be replaced. The electrode is stored wet.

Specifications

Response Time	~10 sec
Slope	55 mV per pH, range of 1 to 14
Impedance	200 M Ω
Stability	0.05 pH per day
Dimensions, L x D	91.4 x 1.6 mm (3 x 0.06 in)

Catalog No.	$	Product
BS4 69-0496		Combination pH Electrode for Free Flap Surgery

Protein Resistant pH Electrodes



- Ideal for determining pH in samples that contain protein
- Faster response times than traditional pH electrodes
- More accurate than traditional pH electrodes
- Longer electrode life — more economical
- Five styles available to meet most application needs
- pH range from 2 to 11

Measuring the pH of biological samples containing proteins is difficult. Proteins in solution can combine with silver ions from the electrolyte to clog the pH electrode diaphragm. This leads to long response times, inaccurate pH measurements, and eventually discarded electrodes. These protein resistant electrodes are designed for rapid, accurate, and reproducible pH measurements of protein containing solutions.

Unique to these pH electrodes is the specially formulated Protelyte™ reference electrolyte. Protelyte™ electrolyte prevents the precipitation of proteins on the electrode diaphragm. You get faster, more accurate, reproducible pH measurements of your samples. Select from five specialized electrodes. The best electrode for you depends upon your applications, physical size limitations, and temperature range. Each has a pH range of 2 to 11.

Specifications

Catalog No.	$	Outer Electrode	Length	Diameter	Temp. Range
BS4 69-0070		Minitrode™ P	100 mm	3 mm	0° to 60°C
BS4 69-0071		Spintrode™ P	180 mm	3 mm	0° to 60°C
BS4 69-0072		Freezetrode™	120 mm	12 mm	-20°C to 80°C
BS4 69-0073		Flushtrode™ P	120 mm	12 mm	10° to 50°C
BS4 69-0074		Tiptrode™	25 mm	6 mm	0° to 80°C

Minitrode™ P
The small size of this sensor makes it ideal for pH measurement of sample in microplates and microcentrifuge tubes. The sensor tip is 3 mm diameter with a usable length of 100 mm (3.9 inches).

Freezetrode™
This sensor is ideal for measuring the pH of samples stored in cold rooms. Select this sensor if your sample is between -20° to +80°C. It has a 12 mm diameter tip.

Flushtrode™ P
If your sample contains between 5 to 85% water, this is the ideal sensor for you. It is good for determining pH of buffer solutions. It has a 12 mm diameter tip.

Tiptrode™
This pH sensor was designed for pH measurements in applications requiring penetration of solid and semi-solid materials including: foods, gelatinous materials, and viscous buffers. It has a 6 mm tip.

Spintrode™ P
Use the SPINTRODE™ to determine the pH of samples in NMR tubes. The 3 mm diameter, 180 mm (7 inch) long sensor allows you to determine the pH without transferring the sample from the NMR tube.

These pH Electrodes are supplied individually and have S7 type connectors. To ensure the most accurate pH measurements, calibrate your electrodes with DURACAL™ Buffer Solutions, see next page for more information.

Catalog No.	$	Product
BS4 69-0075		Protelyte™ Reference Electrolyte Solution, 100 ml
BS4 69-0076		Electrode Storage Solution, 500 ml
BS4 69-0077		Electrode Connecting Cable, BNC to AS7, 1 m (3.3 ft)
BS4 69-0078		Electrode Connecting Cable, DIN to AS7, 1 m (3.3 ft)
BS4 69-0079		Electrode Connecting Cable, Metrohm (Lemo) to AS7, Type F, 1 m (3.3 ft)
BS4 69-0080		Electrode Connecting Cable, Metrohm (Lemo) to AS7, Type H, 1 m (3.3 ft)
BS4 69-0081		Electrode Connecting Cable, Radiometer to AS7, 1 m (3.3 ft)
BS4 69-0082		Electrode Connecting Cable, Standard US to AS7, 1 m (3.3 ft)

For DURACAL™ Buffer Solutions, see page M27

For the AMANI series of 'LEAK-FREE' pH Electrodes, see pages M24

For Microminiature pH Electrodes, O_2 Electrodes and CO_2 Electrodes, see pages M23 and M25

DURACAL™ Buffers

Accurate, stable buffers are critical for the calibration of pH and redox electrodes to achieve accurate measurements, particularly with modern pH meters incorporating GLP functions for recording electrode performance. DURACAL™ pH and Redox Buffer solutions are the buffers you can trust. They offer you many advantages over traditional buffer solutions: guaranteed five year stability, excellent stability of even pH 9.21 in air, see Figure 1, automatic buffer recognition so you use the correct buffer to calibrate. All of this in a unique time saving, money saving dispensing bottle.

DURACAL Buffers are guaranteed for 5 years from the date of production. During this time they retain a high buffer capacity for fast, stable calibrations. The pH 7.00 buffer is less sensitive to ions while the pH 9.21 buffer provides stability superior to conventional buffers. See Figure 1 for a comparison of DURACAL™ and conventional buffer stability when subjected to prolonged air exposure.

The unique, easy-to-use, CALPACK™ dispensing bottle allow electrode calibration in the buffer bottle without contamination. In 4 easy steps, calibration is complete, see Figure 2. It's that simple! No more searching for a suitable container, no more cleaning, no more risk of contamination, and no more wasted buffer from overfilling a container. The composition of DURACAL™ Buffers has been optimized so the temperature function is similar to that of conventional buffers. This guarantees that the automatic buffer recognition of most pH meters can be used without any problems.

- Stable, guaranteed 5 year buffer lifetime
- Unique time saving CALPACK™ dosing bottle
  - — No more searching for suitable containers
  - — No more cleaning
  - — No more risk of contamination
- Economical and easy to dispense only the required quantity of buffer for calibration, no wasted buffer
- Automatic buffer recognition with a majority of pH meters
- Certified, traceable to N.I.S.T.

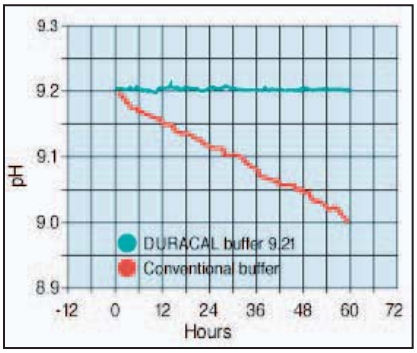


Figure 1

Duracal™ Buffers					
Specifications	**pH 4.01**	**pH 7.00**	**pH 9.21**	**pH 10.01**	**Redox +475 mV**
pH	±0.02	±0.02	±0.02	±0.02	±5 mV
Solution Color	Red	Green	Blue	Yellow	Yellow
1 Bottle, 500 ml $	**BS4 69-0083**	**BS4 69-0084**	**BS4 69-0085**	**BS4 69-0086**	**BS4 72-7140**
Multipack (500 ml x 3) $	**BS4 69-0088**	**BS4 69-0089**	**BS4 69-0090**	**BS4 69-0091**	–

Catalog No.	$	Product
BS4 69-0092		Buffer Set, One 500 ml Bottle of 4.01, 7.00 and 9.21
BS4 72-7141		Buffer Set, One 500 ml Bottle of 4.01, 7.00 and 10.01

Step 1. Unscrew cap to access calibration compartment.

Step 2. Squeeze CALPAK™ bottle to force buffer into compartment

Step 3. Insert electrode for calibration.

Step 4. Turn CALPAK™ bottle on its side to dispose of used buffer.

Figure 2: Calibrating Electrodes in the CALPAK™ Dosing Bottle

Reference Electrodes

LEAK-FREE Reference Electrodes

The 'LEAK FREE' reference electrodes were developed to eliminate the problems associated with the use of conventional porous junction-based reference electrodes such as clogging, sample contamination, electrolyte loss, changing of ionic strength of the sample, and the difficulties with organic based solvents. They utilize a unique junction that is highly conductive (< 10 K Ω) but not porous. There is no solution migrating through the junction in either direction. The reference is totally *leak free*! The junction is resistant to most commonly used organic solvents. It offers excellent resistance to acetonitrile, DMSO, THF, MEK, acetone, dichloromethane, esters, alcohols, and ketones, hydrofluoric acid or common dilute acids and bases. Unlike conventional reference electrodes, there is no need to store them in concentrated chloride solution. If the electrode is left dry for a long period of time, it should be immersed in water for few hours to recover.

Two sizes of 'LEAK FREE' reference electrodes are available, see ordering chart below for details. Other custom configuration of the leak-free reference electrode are available, please consult with Harvard Apparatus Technical Sales Department.

Low-Leakage Reference Electrodes

The low-leakage reference electrodes are for use in applications where contamination would interfere with the application. The electrode junctions are resistant to most commonly used organic solvents. They offer excellent resistance to acetonitrile, DMSO, THF, MEK, acetone, dichloromethane, esters, alcohols, and ketones. Hydrofluoric acid or common dilute acids and bases have no effect on the on these electrodes.

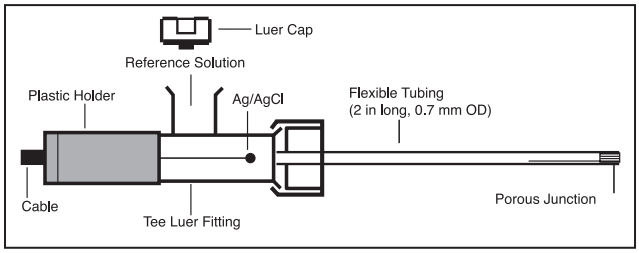
Two low-leakage reference electrodes are available. One is 2 mm (0.08 in) in diameter and the second is 5 mm (0.2 in) in diameter. Other custom configurations of the low-leakage reference electrodes are available, please call the Harvard Apparatus Technical Sales Department.

Specifications

	Low-Leakage Reference Electrodes		LEAK-FREE Reference Electrodes	
Diameter	2 mm (0.08 in)	5 mm (0.2 in)	1 mm (0.04 in)	2 mm (0.08 in)
Length	130 mm (5.1 in)	130 mm (5.1 in)	100 mm (3.9 in)	65 mm (2.6 in)
Construction	PEEK*	PEEK*	PEEK*	PEEK*
Leakage Rate	< 5 x 10-12 l/min	5 x 10-12 l/min	0	0
Filling Electrolyte	3 M KCl	3 M KCl	3 M KCl	3 M KCl
Electrical Connection	2 mm pin on 30 in lead	2 mm pin	1 mm gold plated pin	1 mm gold plated pin
Junction Resistance	< 2.5 K Ω†	< 1 K Ω†	< 10 K Ω†	< 10 K Ω†
Temperature Range	5° to 80°C	5° to 80°C	5° to 80°C	5° to 80°C
Storage	3 M KCl	3 M KCl	Distilled water	Distilled water
Catalog No.	**BS4 69-0024**	**BS4 69-0025**	**BS4 69-0053**	**BS4 69-0023**
$				

* *Polyetherether Ketone*
† *In 1 M potassium chloride*

Flexible Reference Electrode



This miniature flexible reference electrode is 3 inches long and has an outside diameter of 2 mm. It comes complete with a 4 foot long cable and is terminated with an alligator clip connector. Each unit comes pre-filled with the reference solution 3.0 M NaCl in 25% Glycerol) and it is stored dry. If refilling is ever required, reference solution can be injection into the side of the tee fitting and flexible tube portion of the electrode.

Catalog No.	$	Product
BS4 69-0490		Flexible Reference Electrode

For Ag-AgCl Reference Electrodes, see pages M30 and M31.

Auto Chloridizer 863 Kit

- Simple means to chloridize Ag/AgCl electrodes
- Environmentally safe

The electrolytic chloridation unit Auto Chloridizer 863 provides a simple means for the chloridation of Ag/AgCl electrodes. It covers the surface of the silver electrode with an AgCl film insoluble in water. Unlike a purely chemical procedure, electrolytic chloridation does not involve the use of substances endangering the environment. It is normal practice to work with physiological saline solution (NaCl) as the electrolyte.

The electrolytic chloridation method also offers excellent reproducibility of the AgCl film at constant current density and chloridation time. The auto chloridizer operates with an electronically controlled constant-current source with current monitoring and error indication through an LED and error beep. During the chloridation of a single Ag/AgCl electrode the unit is operated manually through the start/stop key.

For routine production of several identical electrodes, such as Ag/AgCl wires for glass microelectrodes, the unit offers a simple programming feature for the chloridation period in the repeat mode. First the learning mode is initiated by pressing the repeat key (for longer than 1 second) and then an electrode is produced manually using the start/stop key. All further electrodes are then prepared automatically according to the manual setting by pressing the repeat key. The end of the chloridation process is indicated by a beep and the current source is automatically switched off.

The counter electrode (cathode) used is a carbon-glass ceramic crucible. This material has a very high electrical conductivity, is very largely inert physiologically, and resistant to oxidation and corrosion. There is therefore no contamination of the AgCl film through free metal ions, as is the case when using stainless steel as a cathode for example.

Specifications

Chloridation Current	Electronically controlled constant current source with current monitoring facility, and with low/medium/high selection by switch, corresponding to approx. 5/10/15 mA respectively
Chloridation Voltage	Max. driving voltage of constant current source is approx. 15 V and is therefore completely safe for user
Start/Stop	Manual operating mode start/stop for chloridation of single electrodes
Repeat	Automatic repetition of manually set chloridation procedure
Dimensions, H x W x D	15 x 6 x 12 cm (5.9 x 2.4 x 4.7 in)
Weight	750 g (1.7 lb)

Catalog No.	$	Product
BS4 73-0004		HSE Auto Chloridizer Model 863, 115 VAC, 60 Hz
BS4 73-0005		HSE Auto Chloridizer Model 863, 230 VAC, 50 Hz
BS4 73-0006		Spare Crocodile Clips
BS4 73-0007		Maintenance Kit for Silver Electrodes, Emery Paper and Scotch-Brite Cleaning Sponge, for Cleaning Silver Electrode before Chloridation

Microelectrode Starter Kit

This starter kit makes entry into microelectrode production technology easy for researchers who have not yet produced any microelectrodes themselves. It contains all the necessary aids, components and consumables. A puller must be purchased separately, see page M52. In addition to manual dexterity which is always necessary, the user requires a binocular transmitted-light microscope with eyepiece graticule and up to 500X magnification for optical checking of the tip diameter.

The kit is suitable for producing intracellular microelectrodes using borosilicate glass capillaries with an integral filament, see pages M45 to M49. The filament makes microelectrode filling easy. Special filling devices, such as vacuum filling equipment, are therefore not required. In addition to a transport and storage container for completed microelectrodes, the kit also includes a specially developed electrolytic chloridation unit for producing an AgCl film on silver electrodes, see to the left. Controlled application of the AgCl film through the selection of current density and chloridation period in the case of the electrolytic chloridation method, together with the good reproducibility of the AgCl film, readily justify the increased cost of purchasing the electrical chloridation equipment. By contrast, chemical chloridation involves less equipment but produces poorer chloridation results and has negative effects on the environment.

The kit includes:

Materials: Pack of 1.5 mm OD glass capillaries with filament, 10 m pure silver wire, 0.2 mm dia., fine solder wire, emery paper, Scotch-Brite cleaning sponge, KCl and NaCl powder, connecting pins for the microelectrodes, and sealing wax.

Tools: 18 W, 230 V miniature, curved soldering tweezers, straight soldering tweezers, fixation tweezers, clamping stand as aid for soldering the micro pins, electrolytic chloridation Auto Chloridizer, transport and storage container for micro-electrodes, special microelectrode holder with miniature socket, and illustrated book about the microelectrode technology.

Catalog No.	$	Product
BS4 73-0008		Microelectrode Starter Kit, 115 VAC, 60 Hz
BS4 73-0009		Microelectrode Starter Kit, 230 VAC, 50 Hz

Reference Cells & Ag-AgCl Electrodes

Why Silver-Silver Chloride (Ag-AgCl)?

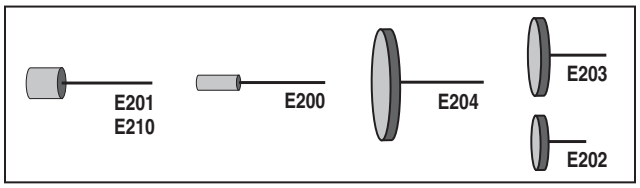
Ag-AgCl electrodes have long been recognized for their superiority in sensing bioelectric signals. The electrochemical properties of Ag-AgCl are such that biopotential waveforms are faithfully reproduced. The main feature that makes them superior to other metals is their low offset potential. In a biomedical situation, the offset potential may be unstable or unpredictable. Long-term changes in offset potential appear as baseline drift, and short-term changes as noise on the trace.

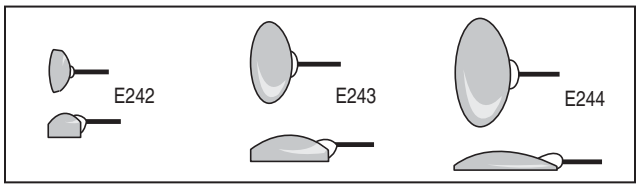
Thus, it is desirable that this potential be as low as possible. The electrode that shows minimum offset is the Ag-AgCl electrode. As the silver chloride is ionized, chloride ions from the electrode are exchanged for similar ions in the tissue or electrolyte. The silver chloride is relatively stable regardless of the direction of the polarizing current flow.

To a great extent, the performance of Ag-AgCl electrodes depends on their formulation. Our electrodes are made from very high purity materials. A careful proprietary process results in a fine grain, homogeneous mixture of silver and silver chloride. A careful sintering process strengthens and stabilizes the entire electrode assembly.

Typical values of the key parameters, measured in 0.9% saline, between pairs of electrodes the same size are:

1) ***DC Offset Voltage:*** *180 µVolts*
2) ***Drift:*** *25 µVolts/hour*
3) ***Noise:*** *1 µVolt peak-to-peak (0.1-1000 Hz with 50/60 Hz eliminated).*





Ag-AgCl Pellet and Disc Electrodes

These six electrodes are ideally suited for making custom assemblies of skin electrodes and other bioelectric recording and stimulation apparatus. All have a pure silver wire (.25 mm diameter x 7 mm) embedded in the Ag-AgCl matrix. This wire can be easily soldered or twisted to other wires.

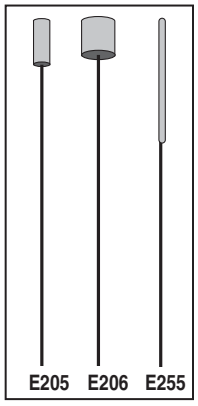
Catalog No.	$	Model	Product
BS4 64-1304		E200	Pellet 1.5 x 3 mm (D x Thick)
BS4 64-1305		E201	Pellet 2.0 x 4 mm (D x Thick)
BS4 64-1313		E210	Pellet 2.0 x 2 mm (D x Thick)
BS4 64-1306		E202	Disc 4.0 x 1 mm (D x Thick)
BS4 64-1307		E203	Disc 8.0 x 1 mm (D x Thick)
BS4 64-1308		E204	Disc 12.5 x 1 mm (D x Thick)

Ag-AgCl Pellet and Wire Electrodes

Pellet electrodes have cylindrical pellet embedded on .25 x 70 mm (D x L) wire.

Wire electrodes have a uniform coating of Ag-AgCl over the last 10 mm of a 0.25 x 70 mm (D x L) wire. Maximum diameter of the Ag-AgCl matrix is 0.8 mm.

Note: All electrodes suitable for probing tissues.



Cat. No.	$	Model	Product
BS4 64-1309		E205	Pellet Electrode 1.0 mm D
BS4 64-1310		E206	Pellet Electrode 2.0 mm D
BS4 64-1317		E255	Wire Electrode 0.8 mm D

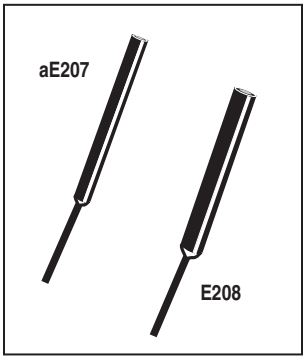
Disc Electrodes With Lead Wires

These disc-type electrodes are made with a flexible 20 cm lead wire attached to the back. The connection is encapsulated so that only the surface and edges of the electrode can make contact. These electrodes can be used as direct-contact skin electrodes, or subcutaneously in temporary applications on research animals.

Catalog No.	$	Model	Product
BS4 64-1314		E242	Disc Electrode 4.0 mm D
BS4 64-1315		E243	Disc Electrode 8.0 mm D
BS4 64-1316		E244	Disc Electrode 12.5 mm D

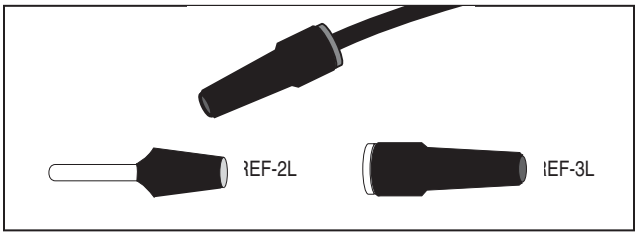
Flat Tip Probes

Ag-AgCl cylinders, encapsulated in sturdy, insulating epoxy tubes; these probes are ideal for use in ionic solutions. They can be resurfaced frequently with fine sandpaper. Terminated with a 2 mm tinned copper wire for connection to your leads.



Catalog No.	$	Model	Product
BS4 64-1311		E207	Sensor Tip 2 x 4 mm (D x Thick) Epoxy Tube 3.5 x 25 mm (D x L)
BS4 64-1312		E208	Sensor Tip 2 x 4 mm (D x Thick) Epoxy Tube 5 x 50 mm (D x L)

Reference Cells & Ag-AgCl Electrodes



Reference Cells

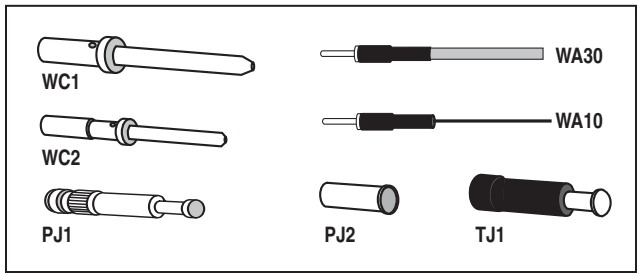
Ag-AgCl electrodes are epoxy encapsulated in a plastic shell. They can be used as preparation reference or ground electrodes. Around 4.5 mm D, they are available with 2 mm pin, 2 mm jack and wire connection. All have a Luer taper for convenient mounting in chambers and other devices.

Catalog No.	$	Model	Product
BS4 64-1301		REF-1L	Reference Cell with 2 m L Wire
BS4 64-1302		REF-2L	Reference Cell with 2 mm Pin
BS4 64-1303		REF-3L	Reference Cell with 2 mm Jack

Silver Wire

Made of annealed silver 99.99% pure. Supplied for the convenience of researchers to fashion their own electrodes.

Catalog No.	$	Model	Product
BS4 64-1318		AG8W	Silver Wire 0.20 mm (.008") D, 2 m L, No Insulation
BS4 64-1319		AG10W	Silver Wire 0.25 mm (.010") D, 2 m L, No Insulation
BS4 64-1320		AG15W	Silver Wire 0.37 mm (.015") D, 2 m L, No Insulation
BS4 64-1321		AGT10W	Silver Wire 0.25 mm (.010") D, 2 m L, Teflon® Insulation



Plugs and Jacks

An assortment of gold-plated 1 mm plugs and jacks, with or without wires. Useful for grounding, shielding, etc.

Catalog No.	$	Model	Product
BS4 64-1325		WC1-10	1 mm Pin, pkg. of 10
BS4 64-1326		WC2-5	2 mm Pin, pkg. of 5
BS4 64-1322		PJ1-10	1 mm Jack, Uninsulated, pkg. of 10
BS4 64-1323		PJ2-5	2 mm Jack, Uninsulated, pkg. of 5
BS4 64-1324		TJ1-3	1 mm Jack, Teflon® Insulated, pkg. of 3
BS4 64-1328		WA30-5	1 mm Pin with 30 cm L, 26 ga. Insulated Wire, pkg. of 3
BS4 64-1327		WA10-5	1 mm Pin with 10 cm L, .25 mm D Bare Silver Wire, pkg. of 2

Electrode Holders

E Series Holders

Applications

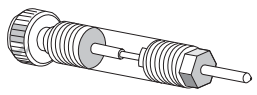
- Intracellular Recording
- Microiontophoresis

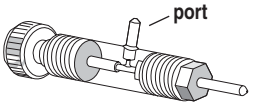
Specifications

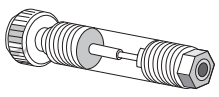
Body Material	Acrylic
Body Styles	Straight, 45°, and 90°
Connectors	2 mm Pin or 2 mm Jack
Coupling	Ag Wire or Ag-AgCl Pellet
Port	2 mm diameter Polycarbonate
Vent	0.8 mm diameter Hole
Standard Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm

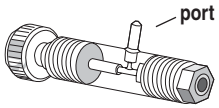
E SERIES-Straight Body Holders

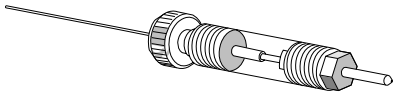
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-0992		Pellet	2 mm Pin	No	1.0	ESP-M10N
BS4 64-0993					1.2	ESP-M12N
BS4 64-0994					1.5	ESP-M15N
BS4 64-1260					2.0	ESP-M20N
BS4 64-0995				Yes	1.0	ESP-M10P
BS4 64-0996					1.2	ESP-M12P
BS4 64-0997					1.5	ESP-M15P
BS4 64-0998					2.0	ESP-M20P
BS4 64-0980			2 mm Jack	No	1.0	ESP-F10N
BS4 64-0981					1.2	ESP-F12N
BS4 64-0982					1.5	ESP-F15N
BS4 64-0983					2.0	ESP-F20N
BS4 64-0984				Yes	1.0	ESP-F10P
BS4 64-0985					1.2	ESP-F12P
BS4 64-0986					1.5	ESP-F15P
BS4 64-0987					2.0	ESP-F20P
BS4 64-1011		Wire	2 mm Pin	No	1.0	ESW-M10N
BS4 64-1012					1.2	ESW-M12N
BS4 64-1013					1.5	ESW-M15N
BS4 64-1014					2.0	ESW-M20N
BS4 64-1015				Yes	1.0	ESW-M10P
BS4 64-1016					1.2	ESW-M12P
BS4 64-1017					1.5	ESW-M15P
BS4 64-1018					2.0	ESW-M20P

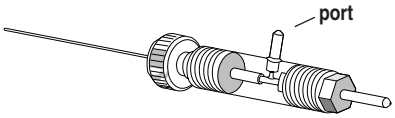










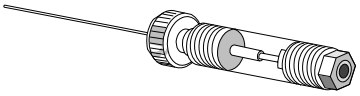


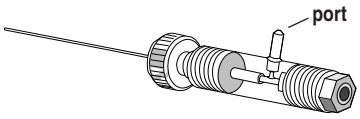
Specialized Tools For Bioresearch

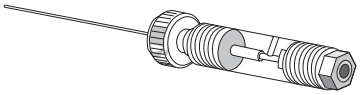
E Series Holders

E SERIES-Straight Body Holders (Continued)

Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-0999		Wire	2 mm Jack	No	1.0	ESW-F10N
BS4 64-1000					1.2	ESW-F12N
BS4 64-1001					1.5	ESW-F15N
BS4 64-1002					2.0	ESW-F20N
BS4 64-1003				Yes	1.0	ESW-F10P
BS4 64-1004					1.2	ESW-F12P
BS4 64-1005					1.5	ESW-F15P
BS4 64-1006					2.0	ESW-F20P
BS4 64-1007				Vent*	1.0	ESW-F10V
BS4 64-1008					1.2	ESW-F12V
BS4 64-1009					1.5	ESW-F15V
BS4 64-1010					2.0	ESW-F20V



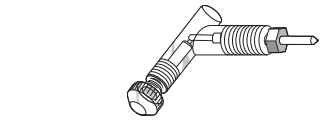


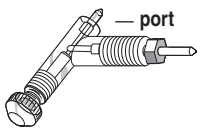


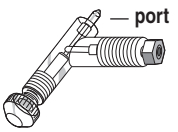
Vented models are standard with the Warner OC-725 Oocte Clamp.

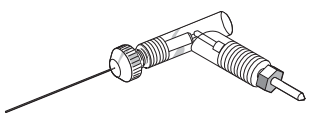
E Series-45° Body Holders

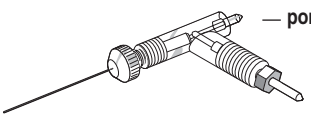
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-0908		Pellet	2 mm Pin	No	1.0	E45P-M10N
BS4 64-0909					1.2	E45P-M12N
BS4 64-0910					1.5	E45P-M15N
BS4 64-0911					2.0	E45P-M20N
BS4 64-0912				Yes	1.0	E45P-M10P
BS4 64-0913					1.2	E45P-M12P
BS4 64-0914					1.5	E45P-M15P
BS4 64-0915					2.0	E45P-M20P
BS4 64-0900			2 mm Jack	No	1.0	E45P-F10N
BS4 64-0901					1.2	E45P-F12N
BS4 64-0902					1.5	E45P-F15N
BS4 64-0903					2.0	E45P-F20N
BS4 64-0904				Yes	1.0	E45P-F10P
BS4 64-0905					1.2	E45P-F12P
BS4 64-0906					1.5	E45P-F15P
BS4 64-0907					2.0	E45P-F20P
BS4 64-0924		Wire	2 mm Pin	No	1.0	E45W-M10N
BS4 64-0925					1.2	E45W-M12N
BS4 64-0926					1.5	E45W-M15N
BS4 64-0927					2.0	E45W-M20N
BS4 64-0928				Yes	1.0	E45W-M10P
BS4 64-0929					1.2	E45W-M12P
BS4 64-0930					1.5	E45W-M15P
BS4 64-0931					2.0	E45W-M20P
BS4 64-0916		Wire	2 mm Jack	No	1.0	E45W-F10N
BS4 64-0917					1.2	E45W-F12N
BS4 64-0918					1.5	E45W-F15N
BS4 64-0919					2.0	E45W-F20N

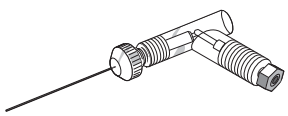










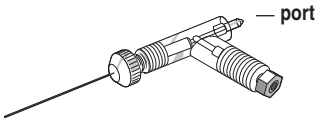


Electrode Holders

E Series Holders

E SERIES-45° Body Holders (Continued)

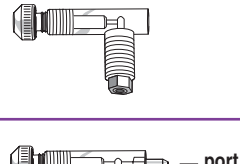
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-0920				Yes	1.0	E45W-F10P
BS4 64-0921					1.2	E45W-F12P
BS4 64-0922					1.5	E45W-F15P
BS4 64-0923					2.0	E45W-F20P

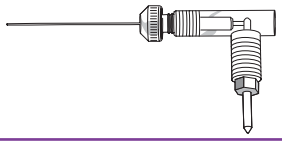


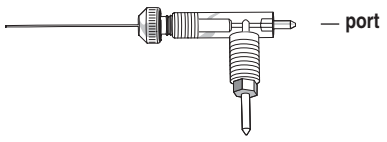
**Vented models are standard with the Warner OC-725 Oocte Clamp.*

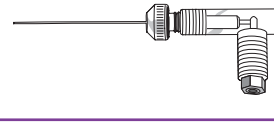
E SERIES-90° Body Holders

Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-0940		Pellet	2 mm Pin	No	1.0	ERP-M10N
BS4 64-0941					1.2	ERP-M12N
BS4 64-0942					1.5	ERP-M15N
BS4 64-0943					2.0	ERP-M20N
BS4 64-0944				Yes	1.0	ERP-M10P
BS4 64-0945					1.2	ERP-M12P
BS4 64-0946					1.5	ERP-M15P
BS4 64-0947					2.0	ERP-M20P
BS4 64-0932			2 mm Jack	No	1.0	ERP-F10N
BS4 64-0933					1.2	ERP-F12N
BS4 64-0934					1.5	ERP-F15N
BS4 64-0935					2.0	ERP-F20N
BS4 64-0936				Yes	1.0	ERP-F10P
BS4 64-0937					1.2	ERP-F12P
BS4 64-0938					1.5	ERP-F15P
BS4 64-0939					2.0	ERP-F20P
BS4 64-0956		Wire	2 mm Pin	No	1.0	ERW-M10N
BS4 64-0957					1.2	ERW-M12N
BS4 64-0958					1.5	ERW-M15N
BS4 64-0959					2.0	ERW-M20N
BS4 64-0960				Yes	1.0	ERW-M10P
BS4 64-0961					1.2	ERW-M12P
BS4 64-0962					1.5	ERW-M15P
BS4 64-0963					2.0	ERW-M20P
BS4 64-0948			2 mm Jack	No	1.0	ERW-F10N
BS4 64-0949					1.2	ERW-F12N
BS4 64-0950					1.5	ERW-F15N
BS4 64-0951					2.0	ERW-F20N
BS4 64-0952				Yes	1.0	ERW-F10P
BS4 64-0953					1.2	ERW-F12P
BS4 64-0954					1.5	ERW-F15P
BS4 64-0955					2.0	ERW-F20P









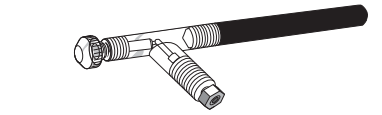
**Vented models are standard with the Warner OC-725 Oocte Clamp.*

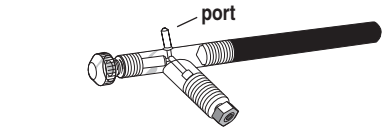
E Series Holders with Handle

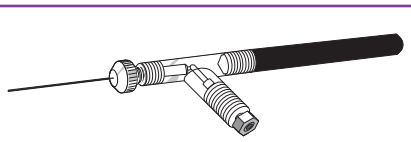
Holders include a 6.3 mm diameter X 6.3 cm long handle for mounting in a micropositioner. Handles are screwed together except for vented models which are joined by a pin and jack for easy removal from the handle.

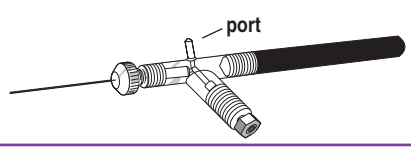
E SERIES with Handle

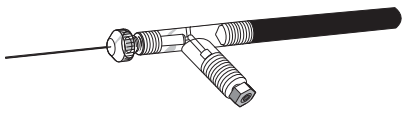
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1023		Pellet	2 mm Jack	No	1.0	E45P-F10NH
BS4 64-1024					1.2	E45P-F12NH
BS4 64-1025					1.5	E45P-F15NH
BS4 64-1026					2.0	E45P-F20NH
BS4 64-1039				Yes	1.0	E45P-F10PH
BS4 64-1040					1.2	E45P-F12PH
BS4 64-1041					1.5	E45P-F15PH
BS4 64-1042					2.0	E45P-F20PH
BS4 64-1019		Wire	2 mm Jack	No	1.0	E45W-F10NH
BS4 64-1020					1.2	E45W-F12NH
BS4 64-1021					1.5	E45W-F15NH
BS4 64-1022					2.0	E45W-F20NH
BS4 64-1035				Yes	1.0	E45W-F10PH
BS4 64-1036					1.2	E45W-F12PH
BS4 64-1037					1.5	E45W-F15PH
BS4 64-1038					2.0	E45W-F20PH
BS4 64-1051				Vent*	1.0	E45W-F10VH
BS4 64-1052					1.2	E45W-F12VH
BS4 64-1053					1.5	E45W-F15VH
BS4 64-1054					2.0	E45W-F20VH







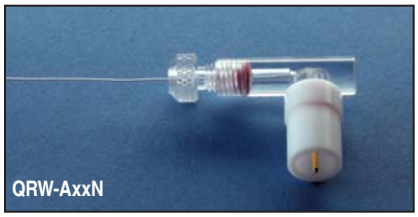




**Vented models are standard with the Warner OC-725 Oocte Clamp.*

Electrode Holders

Q Series Holders



Applications

- Patch Clamp Recording
- Intracellular Recording

Specifications

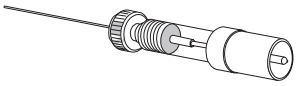
Body Material	Polycarbonate
Body Styles	Straight, 45°, and 90°
Connectors	1 mm Pin, 1 mm Pin Threaded and BNC
Coupling	Ag Wire or Ag-AgCl Hybrid
Port	2 mm diameter Polycarbonate
Standard Glass Sizes	1.0, 1.2, 1.5, 1.7 and 2.0 mm

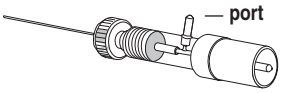
Compatible with Warner Patch Clamps PC-501 & PC-505 and Axon Patch Clamps (older style prior to 2/1/95)

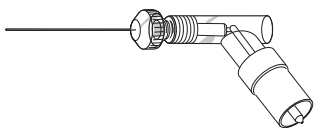
NOTE: Holders without ports are not suitable for patch clamp recording.

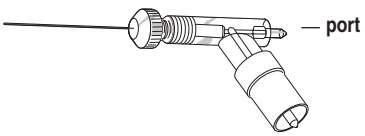
Q SERIES Holders with 1 mm Pin

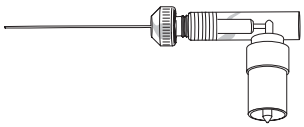
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1105		Wire	Straight	No	1.0	QSW-A10N
BS4 64-1106					1.2	QSW-A12N
BS4 64-1107					1.5	QSW-A15N
BS4 64-0745					1.7	QSW-A17N
BS4 64-1108					2.0	QSW-A20N
BS4 64-0821				Yes	1.0	QSW-A10P
BS4 64-0822					1.2	QSW-A12P
BS4 64-0823					1.5	QSW-A15P
BS4 64-0978					1.7	QSW-A17P
BS4 64-0824					2.0	QSW-A20P
BS4 64-0841			45°	No	1.0	Q45W-A10N
BS4 64-0842					1.2	Q45W-A12N
BS4 64-0843					1.5	Q45W-A15N
BS4 64-1098					1.7	Q45W-A17N
BS4 64-0844					2.0	Q45W-A20N
BS4 64-1055				Yes	1.0	Q45W-A10P
BS4 64-1056					1.2	Q45W-A12P
BS4 64-1057					1.5	Q45W-A15P
BS4 64-0968					1.7	Q45W-A17P
BS4 64-1058					2.0	Q45W-A20P
BS4 64-0861			90°	No	1.0	QRW-A10N
BS4 64-0862					1.2	QRW-A12N
BS4 64-0863					1.5	QRW-A15N
BS4 64-1103					1.7	QRW-A17N
BS4 64-0864					2.0	QRW-A20N







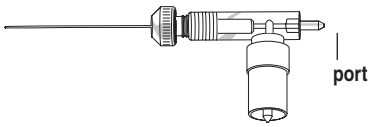


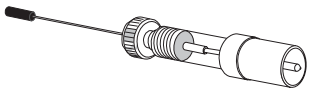


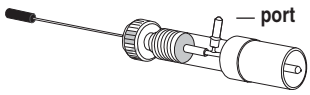
Q Series Holders

Q SERIES Holders with 1 mm Pin (Continued)

Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1075				Yes	1.0	QRW-A10P
BS4 64-1076					1.2	QRW-A12P
BS4 64-1077					1.5	QRW-A15P
BS4 64-0973					1.7	QRW-A17P
BS4 64-1078					2.0	QRW-A20P
BS4 64-1351		Hybrid	Straight	No	1.5	QSH-A15N
BS4 64-1352					1.7	QSH-A17N
BS4 64-1353					2.0	QSH-A20N
BS4 64-1354				Yes	1.5	QSH-A15P
BS4 64-1355					1.7	QSH-A17P
BS4 64-1356					2.0	QSH-A20P





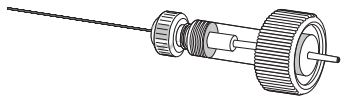


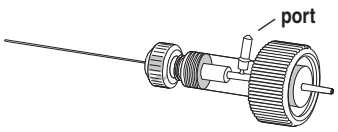
Compatible with: Axon Patch Clamps and Microelectrode Amps post 2/1/95

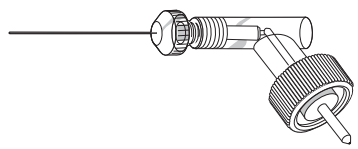
NOTE: Holders without ports are not suitable for patch clamp recording.

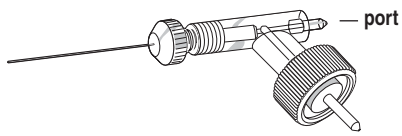
Q SERIES Holders with 1 mm Pin, Threaded Collar

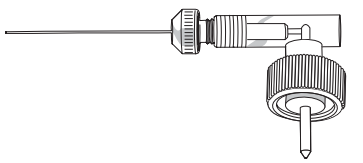
Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1121		Wire	Straight	No	1.0	QSW-T10N
BS4 64-1122					1.2	QSW-T12N
BS4 64-1123					1.5	QSW-T15N
BS4 64-0749					1.7	QSW-T17N
BS4 64-1124					2.0	QSW-T20N
BS4 64-0837				Yes	1.0	QSW-T10P
BS4 64-0838					1.2	QSW-T12P
BS4 64-0839					1.5	QSW-T15P
BS4 64-1097					1.7	QSW-T17P
BS4 64-0840					2.0	QSW-T20P
BS4 64-0857			45°	No	1.0	Q45W-T10N
BS4 64-0858					1.2	Q45W-T12N
BS4 64-0859					1.5	Q45W-T15N
BS4 64-1102					1.7	Q45W-T17N
BS4 64-0860					2.0	Q45W-T20N
BS4 64-1071				Yes	1.0	Q45W-T10P
BS4 64-1072					1.2	Q45W-T12P
BS4 64-1073					1.5	Q45W-T15P
BS4 64-0972					1.7	Q45W-T17P
BS4 64-1074					2.0	Q45W-T20P
BS4 64-0877			90°	No	1.0	QRW-T10N
BS4 64-0878					1.2	QRW-T12N
BS4 64-0879					1.5	QRW-T15N
BS4 64-0744					1.7	QRW-T17N
BS4 64-0880					2.0	QRW-T20N







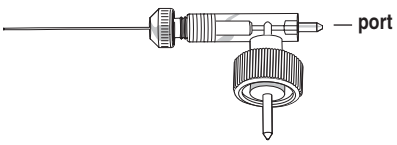


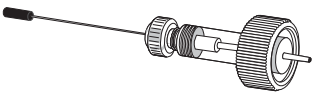


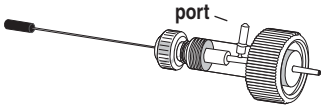
Q Series Holders

Q SERIES Holders with 1 mm Pin, Threaded Collar (Continued)

Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1091				Yes	1.0	QRW-T10P
BS4 64-1092					1.2	QRW-T12P
BS4 64-1093					1.5	QRW-T15P
BS4 64-0977					1.7	QRW-T17P
BS4 64-1094					2.0	QRW-T20P
BS4 64-1363		Hybrid	Straight	No	1.5	QSH-T15N
BS4 64-1364					1.7	QSH-T17N
BS4 64-1365					2.0	QSH-T20N
BS4 64-1366				Yes	1.5	QSH-T15P
BS4 64-1367					1.7	QSH-T17P
BS4 64-1368					2.0	QSH-T20P



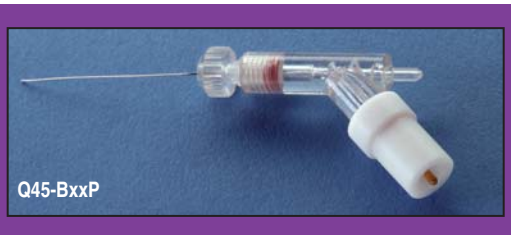




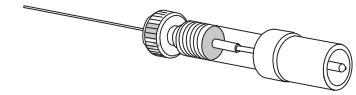
Compatible with: Heka, List and Dagan Patch Clamps

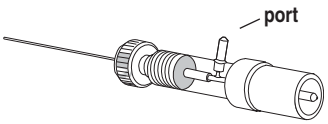
NOTE: Holders without ports are not suitable for patch clamp recording.

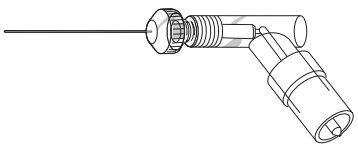
Q SERIES Holders with BNC Connector

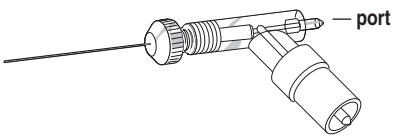


Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model
BS4 64-1109		Wire	Straight	No	1.0	QSW-B10N
BS4 64-1110					1.2	QSW-B12N
BS4 64-1111					1.5	QSW-B15N
BS4 64-0746					1.7	QSW-B17N
BS4 64-1112					2.0	QSW-B20N
BS4 64-0825				Yes	1.0	QSW-B10P
BS4 64-0826					1.2	QSW-B12P
BS4 64-0827					1.5	QSW-B15P
BS4 64-0979					1.7	QSW-B17P
BS4 64-0828					2.0	QSW-B20P
BS4 64-0845			45°	No	1.0	Q45W-B10N
BS4 64-0846					1.2	Q45W-B12N
BS4 64-0847					1.5	Q45W-B15N
BS4 64-1099					1.7	Q45W-B17N
BS4 64-0848					2.0	Q45W-B20N
BS4 64-1059				Yes	1.0	Q45W-B10P
BS4 64-1060					1.2	Q45W-B12P
BS4 64-1061					1.5	Q45W-B15P
BS4 64-0969					1.7	Q45W-B17P
BS4 64-1062					2.0	Q45W-B20P



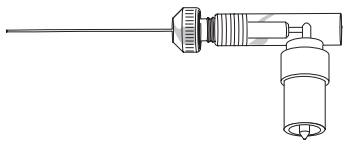
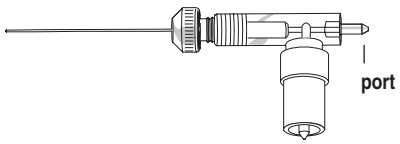
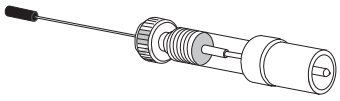
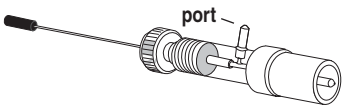






Q Series Holders

Q SERIES Holders with BNC Connector (Continued)

Catalog No.	$	Wire/Pellet	Connector	Port	Glass OD (mm)	Model	
BS4 64-0865			90°	No	1.0	QRW-B10N	
BS4 64-0866					1.2	QRW-B12N	
BS4 64-0867					1.5	QRW-B15N	
BS4 64-1104					1.7	QRW-B17N	
BS4 64-0868					2.0	QRW-B20N	
BS4 64-1079				Yes	1.0	QRW-B10P	
BS4 64-1080					1.2	QRW-B12P	
BS4 64-1081					1.5	QRW-B15P	
BS4 64-0974					1.7	QRW-B17P	
BS4 64-1082					2.0	QRW-B20P	
BS4 64-1357		Hybrid	Straight	No	1.5	QSH-B15N	
BS4 64-1358					1.7	QSH-B17N	
BS4 64-1359					2.0	QSH-B20N	
BS4 64-1360				Yes	1.5	QSH-B15P	
BS4 64-1361					1.7	QSH-B17P	
BS4 64-1362					2.0	QSH-B20P	

PE Series Holders

Applications

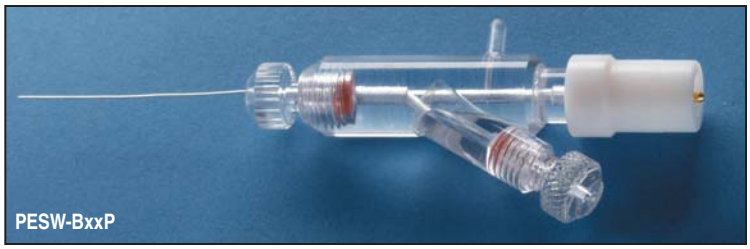
- Microperfusion (perfusion at the pipette tip)*

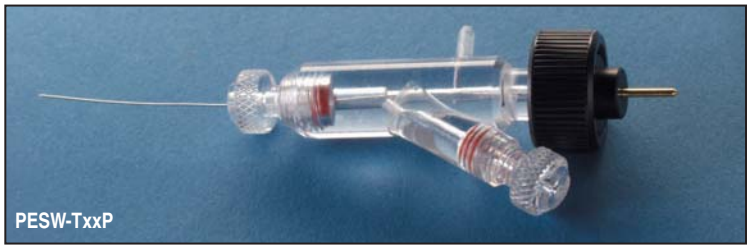
Specifications

Body Material	Polycarbonate
Body Style	Straight
Connectors	1 mm Pin, 1 mm Pin Threaded and BNC
Coupling	Ag Wire
Port	2 mm diameter Polycarbonate
Perfusion Port	30° port accepts tubing up to 1 mm diameter
Standard Glass Sizes	1.0, 1.2, 1.5, 1.7 and 2.0 mm

Patch Clamp Compatibility

Connector	For Use With
1 mm Pin	Warner Patch Clamp Models PC-501 & PC-505 Axon Patch Clamps prior to 2/1/95
BNC	List, Heka and Dagan Patch Clamps
1 mm Pin with threaded collar	Axon Patch Clamps and Microelectrode Amps prior to 2/1/95


PESW-BxxP

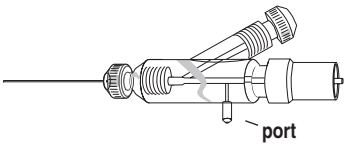

PESW-TxxP

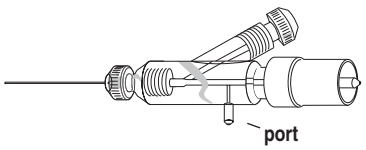
For Microperfusion (perfusing inside the micropipette)

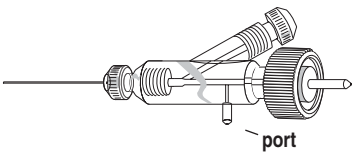
Perfusion at the electrode tip is possible with the PE Series holders. They include an additional port at 30° to the glass bore allowing for the insertion of micro-bore tubing into the pipette. This port includes a threaded cap and seal for up to 1 mm diameter tubing. See the reports referenced below for information on the microperfusion technique.

PE SERIES Holders

Catalog No.	$	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model
BS4 64-1144		Wire	Straight	Yes	1 mm Pin	1.0	PESW-A10P
BS4 64-1145						1.2	PESW-A12P
BS4 64-1146						1.5	PESW-A15P
BS4 64-1371						1.7	PESW-A17P
BS4 64-1147						2.0	PESW-A20P
BS4 64-1148					BNC	1.0	PESW-B10P
BS4 64-1149						1.2	PESW-B12P
BS4 64-1150						1.5	PESW-B15P
BS4 64-1369						1.7	PESW-B17P
BS4 64-1151						2.0	PESW-B20P
BS4 64-1160					1 mm pin	1.0	PESW-T10P
BS4 64-1161					Threaded	1.2	PESW-T12P
BS4 64-1162					Collar	1.5	PESW-T15P
BS4 64-1373						1.7	PESW-T17P
BS4 64-1163						2.0	PESW-T20P







References:

1) *Nehr, E. and Eckert, R.: Fast patch-pipette internal perfusion with minimum solution flow. Grinnel, A.D., Armstrong, D. and Jackson, M.B.: Calcium and Ion Channel Modulation, Plenum Press, N.Y.*

2) *Cull-Candy, S.G., Miledi, R. and Parker, I.: Single glutamate-activated channels recorded from locust muscle fibers with perfused patch clamp electrodes. J. Physiology 32-, 195-210.*

3) *Pusch, M. and Nehr, E. (1987) Kinetics of loading small cells with various compounds by use of patch pipettes. Pflugers Archives (Spring Meeting of the Physiol. Ges.).*

4) *Tang, J.M., Wang, J. and Eisenberg, R.S. (1992) Perfusing patch pipettes. Methods in Enzymol. 207, 176-181.*

ME Series Holders

Applications

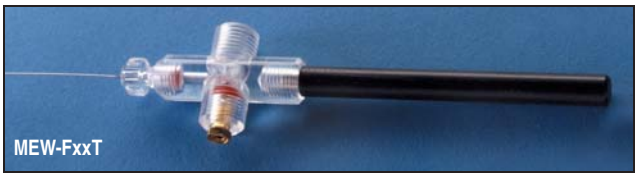
- Intracellular and Extracellular Recording
- Microiontophoresis

Pressure Ports

A	– Accepts 1.5 mm (1/16") tubing
B	– Accepts 2.4 mm (3/32") tubing
ML	– Accepts female Luer fitting
FL	– Accepts male Luer fitting
T*	– Accepts 1/4-28 male thread fitting

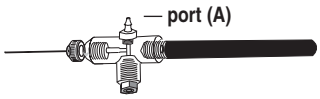
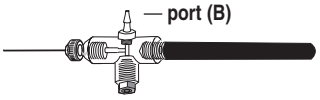
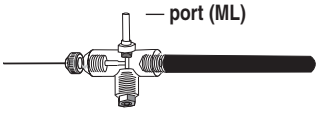
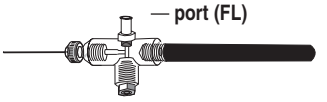
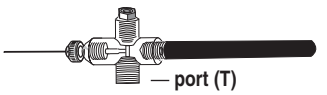
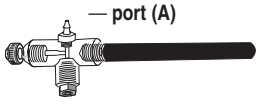
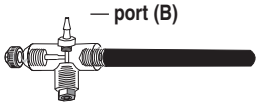
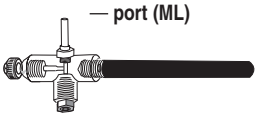
Specifications

Body Material	9.3 mm diameter acrylic
Body Style	Straight
Connector	2 mm jack
Coupling	Ag/AgCl pellet or Ag Wire
Standard Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.



** Holders with the T port are compatible with the Picospritzer® system made by General Valve Corp.*

PE SERIES Holders

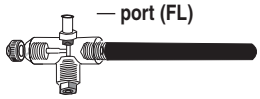
Catalog No.	$	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model	
BS4 64-1220		Straight	2 mm Jack	Wire	1/16" barb	1.0	MEW-F10A	
BS4 64-1221						1.2	MEW-F12A	
BS4 64-1222						1.5	MEW-F15A	
BS4 64-1223						2.0	MEW-F20A	
BS4 64-1224					1/32" barb	1.0	MEW-F10B	
BS4 64-1225						1.2	MEW-F12B	
BS4 64-1226						1.5	MEW-F15B	
BS4 64-1227						2.0	MEW-F20B	
BS4 64-1232					male Luer	1.0	MEW-F10ML	
BS4 64-1233						1.2	MEW-F12ML	
BS4 64-1234						1.5	MEW-F15ML	
BS4 64-1235						2.0	MEW-F20ML	
BS4 64-1228					female Luer	1.0	MEW-F10FL	
BS4 64-1229						1.2	MEW-F12FL	
BS4 64-1230						1.5	MEW-F15FL	
BS4 64-1231						2.0	MEW-F20FL	
BS4 64-1236					threaded	1.0	MEW-F10T	
BS4 64-1237					1/4-28	1.2	MEW-F12T	
BS4 64-1238						1.5	MEW-F15T	
BS4 64-1239						2.0	MEW-F20T	
BS4 64-1180		Straight	2 mm Jack	Pellet	1/16" barb	1.0	MEP-F10A	
BS4 64-1181						1.2	MEP-F12A	
BS4 64-1182						1.5	MEP-F15A	
BS4 64-1183						2.0	MEP-F20A	
BS4 64-1184					1/32" barb	1.0	MEP-F10B	
BS4 64-1185						1.2	MEP-F12B	
BS4 64-1186						1.5	MEP-F15B	
BS4 64-1187						2.0	MEP-F20B	
BS4 64-1192					male Luer	1.0	MEP-F10ML	
BS4 64-1193						1.2	MEP-F12ML	
BS4 64-1194						1.5	MEP-F15ML	
BS4 64-1195						2.0	MEP-F20ML	

Electrode Holders

ME Series Holders

PE SERIES Holders (Continued)

Catalog No.	$	Wire/Pellet	Body Style	Port	Connector	Glass OD (mm)	Model
BS4 64-1188					female Luer	1.0	MEP-F10FL
BS4 64-1189						1.2	MEP-F12FL
BS4 64-1190						1.5	MEP-F15FL
BS4 64-1191						2.0	MEP-F20FL
BS4 64-1196					threaded	1.0	MEP-F10T
BS4 64-1197					1/4-28	1.2	MEP-F12T
BS4 64-1198						1.5	MEP-F15T
BS4 64-1199						2.0	MEP-F20T



MP Series Holders

Applications

- Microinjection

Pressure Ports

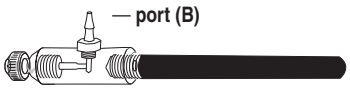
A	– Accepts 1.5 mm (1/16") tubing
B	– Accepts 2.4 mm (3/32") tubing
ML	– Accepts female Luer fitting
FL	– Accepts male Luer fitting
T*	– Accepts 1/4-28 male thread fitting

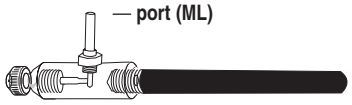
Specifications

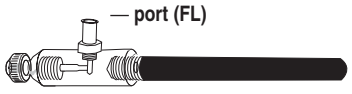
Body Material	Acrylic
Body Style	Straight
Port	1/16" barbed (1/16" tubing ID), 3/32" barbed (3/32" tubing ID), male Luer, female Luer and 1/4-28 female threaded
Standard Glass Sizes	1.0, 1.2, 1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.

MP SERIES Holders

Catalog No.	$	Body Style	Port	Glass OD (mm)	Model
BS4 64-1261		Straight	1/16" barb	1.0	MP-S10A
BS4 64-1262				1.2	MP-S12A
BS4 64-1263				1.5	MP-S15A
BS4 64-1264				2.0	MP-S20A
BS4 64-1265			1/32" barb	1.0	MP-S10B
BS4 64-1266				1.2	MP-S12B
BS4 64-1267				1.5	MP-S15B
BS4 64-1268				2.0	MP-S20B
BS4 64-1273			male Luer	1.0	MP-S10ML
BS4 64-1274				1.2	MP-S12ML
BS4 64-1275				1.5	MP-S15ML
BS4 64-1276				2.0	MP-S20ML
BS4 64-1269			female Luer	1.0	MP-S10FL
BS4 64-1270				1.2	MP-S12FL
BS4 64-1271				1.5	MP-S15FL
BS4 64-1272				2.0	MP-S20FL
BS4 64-1278			threaded	1.0	MP-S10T
BS4 64-1279			1/4-28	1.2	MP-S12T
BS4 64-1280				1.5	MP-S15T
BS4 64-1281				2.0	MP-S20T







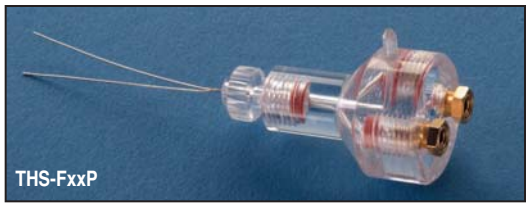
Theta Glass Holders

Applications

- Microinjection or microiontophoresis with theta glass

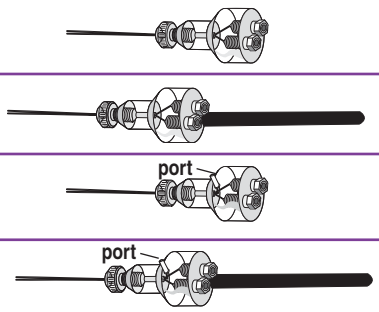
Specifications

Body Material	Acrylic
Body Style	Straight
Coupling	Ag wire (2)
Connector	2 mm jack
Port	2 mm diameter polycarbonate
Standard Glass Sizes	1.5 and 2.0 mm
Handle	6.3 mm diameter x 6.3 cm long, threaded to attach to holder.



Theta Glass Holders

Catalog No.	$	Port	Handle	Glass OD (mm)	Model
BS4 64-1164		No	No	1.5	THS-F15
BS4 64-1165				2.0	THS-F20
BS4 64-1172			Yes	1.5	THS-F15H
BS4 64-1173				2.0	THS-F20H
BS4 64-1168		Yes	No	1.5	THS-F15P
BS4 64-1169				2.0	THS-F20P
BS4 64-1176			Yes	1.5	THS-F15PH
BS4 64-1177				2.0	THS-F20PH



Electrode/Manifold Holders MHH-25, MHH-38

Specifications

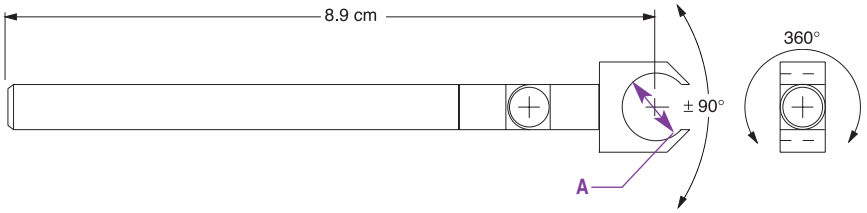
The MHH-25 and MHH-38 Holders permit convenient mounting of manifolds and electrode holders or other devices with 6.3 or 9.5 mm diameters. The holder head can be pivoted ±90° from the axial position and rotated 360° about the axis. Friction holds the head firmly in the set position. Holder head and coupler are made from Delrin®. The anodized aluminum handle is 6.3 mm diameter x 6.3 cm long and will fit most positioners.

Device Compatibility

Catalog No.	$	Model	Description
BS4 64-0218		MHH-25	E and Q Series Electrode Holders
BS4 64-0219		MHH-38	PE Series and Theta Electrode Holders MP and MPP Series Manifolds

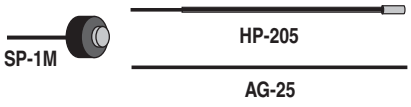
A Diameter

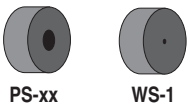
Model	Diameter
MHH-25	6.3 mm (1/4")
MHH-38	9.5 mm (3/8")

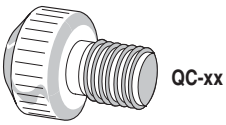


Electrode/Manifold Holders MHH-25, MHH-38

Microelectrode Holder and Replacement Parts				
Catalog No.	**$**	**Qty/Pkg**	**Description**	
Coupling Elements				
BS4 64-1297		3	SP-1M	Molded Ag-AgCl pellet assembly
BS4 64-1282		10	AG25-10	Ag wire, 0.25 mm diameter x 70 mm long
BS4 64-1288		1	HP-205	Hybrid Ag-AgCl pellet/Ag wire assembly
Pipette and Wire Seals				
BS4 64-1289		10	PS-10	Pipette seal for 1.0 mm diameter glass
BS4 64-1290		10	PS-12	Pipette seal for 1.2 mm diameter glass
BS4 64-1291		10	PS-15	Pipette seal for 1.5 mm diameter glass
BS4 64-1374		10	PS-17	Pipette seal for 1.7 mm diameter glass
BS4 64-1292		10	PS-20	Pipette seal for 2.0 mm diameter glass
BS4 64-1298		10	WS-1	Wire seal for E, ME, MP and theta holder
BS4 64-1299		10	WS-2	Wire seal for Q and PE Series holders
BS4 64-1300		10	WS-3	Wire seal for Q and PE Series holders with threaded "T" connector
Glass Seal Compression Caps				
BS4 64-1293		2	QC-10	Compression cap for 1.0 mm glass holders
BS4 64-1294		2	QC-12	Compression cap for 1.2 mm glass holders
BS4 64-1295		2	QC-15	Compression cap for 1.5 mm glass holders
BS4 64-1375		2	QC-17	Compression cap for 1.7 mm glass holders
BS4 64-1296		2	QC-20	Compression cap for 2.0 mm glass holders
Connector Pins and Jacks				
BS4 64-1283		3	HC-10M	1 mm pin for Q and PE holders with A or T connectors
BS4 64-1284		3	HC-13M	1.3 mm pin for Q and PE holders with B (BNC) connector
BS4 64-1285		3	HC-20M	2 mm threaded pin for E, ME and theta holders
BS4 64-1286		3	HC-21F	2 mm jack assembly for all series holders
BS4 64-1287		3	HC-22M	2 mm pin for Q and PE holders with M connector







Premium Capillary Glass

- Ends are fire polished to prevent damage to the rubber gaskets when inserted into electrode holders
- Glass is also cleaned with deionized water before being packed in dust-free containers

Warner capillary glass is known worldwide for its consistent high quality. The glass is precision drawn to insure reliability and consistency from batch to batch. The full line of glass capillaries listed here is stocked for fast shipment.

Standard Wall/Thin Wall

Tubing is available in two wall thickness, standard wall and thin wall. Additionally, a variety of diameters is offered to cover most needs of micropipette and microelectrode research.

Capillaries with Filament

A small diameter filament is fused to the glass inside diameter to facilitate rapid solution filling through capillary attraction. This is especially important for the very small diameter of sharp electrodes typically used for intracellular studies and microiontophoresis.

Premium Corning Type 7740 (Pyrex)

Corning 7740 Borosilicate is the most commonly used glass in electrode fabrication because of its mechanical strength, chemical durability, electrical resistivity, and its ability to withstand thermal stress. It is also easy to work with and suitable for a wide range of applications. Corning 7740 glass is offered in a choice of diameters, in standard or thin-walled format, and either with or without inner filament; they are additionally available in Theta style. Single barrel glass is available in 3 lengths: 75, 100 and150 mm. Theta glass is offered in 100 mm lengths only.

Specifications

Composition	81% SiO_2, 13% B_2O_3, 4% Na_2O, 2% Al_2O_3
Softening Temp.	821°C
Dielectric Constant	4.6

Premium Standard Wall Borosilicate

Premium Standard Wall Borosilicate						
Catalog No.	$	Model	OD mm	ID mm	Length	Qty/Pkg
BS4 64-0765		G100-3	1.0	0.58	75 mm	500
BS4 64-0766		G100-4	1.0	0.58	100 mm	500
BS4 64-0767		G100-6	1.0	0.58	150 mm	500
BS4 64-0768		G120-3	1.2	0.69	75 mm	350
BS4 64-0769		G120-4	1.2	0.69	100 mm	350
BS4 64-0770		G120-6	1.2	0.69	150 mm	350
BS4 64-0771		G150-3	1.5	0.86	75 mm	225
BS4 64-0772		G150-4	1.5	0.86	100 mm	225
BS4 64-0773		G150-6	1.5	0.86	150 mm	225
BS4 64-0774		G200-3	2.0	1.16	75 mm	125
BS4 64-0775		G200-4	2.0	1.16	100 mm	125
BS4 64-0776		G200-6	2.0	1.16	150 mm	125

Premium Thin Wall Borosilicate

Premium Thin Wall Borosilicate						
Catalog No.	$	Model	OD mm	ID mm	Length	Qty/Pkg
BS4 64-0777		G100T-3	1.0	0.78	75 mm	500
BS4 64-0778		G100T-4	1.0	0.78	100 mm	500
BS4 64-0779		G100T-6	1.0	0.78	150 mm	500
BS4 64-0780		G120T-3	1.2	0.94	75 mm	350
BS4 64-0781		G120T-4	1.2	0.94	100 mm	350
BS4 64-0782		G120T-6	1.2	0.94	150 mm	350
BS4 64-0783		G150T-3	1.5	1.17	75 mm	225
BS4 64-0784		G150T-4	1.5	1.17	100 mm	225
BS4 64-0785		G150T-6	1.5	1.17	150 mm	225

Premium Standard Wall Borosilicate with Filament

Premium Standard Wall Borosilicate						
Catalog No.	$	Model	OD mm	ID mm	Length	Qty/Pkg
BS4 64-0786		G100F-3	1.0	0.58	75 mm	500
BS4 64-0787		G100F-4	1.0	0.58	100 mm	500
BS4 64-0788		G100F-6	1.0	0.58	150 mm	500
BS4 64-0789		G120F-3	1.2	0.69	75 mm	350
BS4 64-0790		G120F-4	1.2	0.69	100 mm	350
BS4 64-0791		G120F-6	1.2	0.69	150 mm	350
BS4 64-0792		G150F-3	1.5	0.86	75 mm	225
BS4 64-0793		G150F-4	1.5	0.86	100 mm	225
BS4 64-0794		G150F-6	1.5	0.86	150 mm	225
BS4 64-0795		G200F-3	2.0	1.16	75 mm	125
BS4 64-0796		G200F-4	2.0	1.16	100 mm	125
BS4 64-0797		G200F-6	2.0	1.16	150 mm	125

Premium Thin Wall Borosilicate with Filament

Premium Thin Wall Borosilicate with Filament						
Catalog No.	$	Model	OD mm	ID mm	Length	Qty/Pkg
BS4 64-0798		G100TF-3	1.0	0.78	75 mm	500
BS4 64-0799		G100TF-4	1.0	0.78	100 mm	500
BS4 64-0800		G100TF-6	1.0	0.78	150 mm	500
BS4 64-0801		G120TF-3	1.2	0.94	75 mm	350
BS4 64-0802		G120TF-4	1.2	0.94	100 mm	350
BS4 64-0803		G120TF-6	1.2	0.94	150 mm	350
BS4 64-0804		G150TF-3	1.5	1.17	75 mm	225
BS4 64-0805		G150TF-4	1.5	1.17	100 mm	225
BS4 64-0806		G150TF-6	1.5	1.17	150 mm	225
BS4 64-0807		G200TF-3	2.0	1.56	75 mm	125
BS4 64-0808		G200TF-4	2.0	1.56	100 mm	125
BS4 64-0809		G200TF-6	2.0	1.56	150 mm	125

Premium Theta Glass

Premium Theta Glass (100 pcs/pkg.)						
Catalog No.	$	Model	OD mm	ID mm	Septum	Length
BS4 64-0810		TG150-4	1.5	1.0	0.2 mm	100 mm
BS4 64-0811		TG200-4	2.0	1.4	0.2 mm	100 mm

Patch Clamp Glass

Choosing patch clamp glass is generally based on noise performance and the ability to form and maintain a seal. No one type of glass works best in all applications and some trial and error is usually required to find the type yielding optimum results in your experiment. Patch glass is manufactured without an inner filament. This glass is offered in both the standard and premium models. The premium glass has fire polished ends and is cleaned with deionized water before being packed in dust-free containers.

Custom 8520 Patch Glass

Now Available in Premium Line!

The custom patch glass from Clark was introduced in 1997 as a substitute for the Corning 7052 glass, a favorite amongst researchers performing patch clamping. Initial tests showed the 8520 glass to be equal to the 7052 in noise performance. More importantly, seals were formed faster and maintained for longer periods.

Specifications

Composition	>10% SiO_2, >10% B_2O_3, >1% Al_2O_3, >1% K_2O, <1% Na_2O, <1% Li_2O, <1% ZnO, <1% As_2O_3, <1% TiO_2, <1% ZrO_2
Softening Temperature	720°C
Dielectric Constant	4.6

Premium Custom 8520 Patch Glass

Cat. No.	$	Model	OD mm	ID mm	Length	Qty.
BS4 64-0817		G85150T-3	1.50	1.16	75 mm	225
BS4 64-0818		G85150T-4	1.50	1.16	100 mm	225
BS4 64-0819		G85165T-3	1.65	1.28	75 mm	190
BS4 64-0820		G85165T-4	1.65	1.28	100 mm	190

Clark Custom 8520 Patch Glass

Catalog No.	$	OD	ID	Length	Quantity
BS4 30-0091		1.2 mm	0.93 mm	75 mm	350
BS4 30-0089		1.2 mm	0.93 mm	100 mm	350
BS4 30-0090		1.2 mm	0.93 mm	150 mm	350
BS4 30-0094		1.5 mm	1.16 mm	75 mm	225
BS4 30-0092		1.5 mm	1.16 mm	100 mm	225
BS4 30-0093		1.5 mm	1.16 mm	150 mm	225
BS4 30-0097		1.65 mm	1.28 mm	75 mm	190
BS4 30-0095		1.65 mm	1.28 mm	100 mm	190
BS4 30-0096		1.65 mm	1.28 mm	150 mm	190

Premium Corning 7056 (Alkali Barium Borosilicate) Patch Glass

Now Available in Premium Line!

Corning 7056 glass is now offered in place of the 7052 glass, last melted in 1992 and no longer available. The 7056 formula has also been discontinued by Corning (last melt in 1995) but stocks of this material should be available for a few more years. The properties of the 7056 glass are similar to the 7052 as is its performance in patch experiments.

Specifications

Composition	68% SiO_2, 18% B_2O_3, 9% K_2O, 3% Al_2O_3, 1% Li_2O, 1% Na_2O
Softening Temperature	718°C
Dielectric Constant	5.7

Premium Corning 7056 Patch Glass

Cat. No.	$	Model	OD mm	ID mm	Length	Qty.
BS4 64-0812		G75150S-4	1.50	0.75	100 mm	225
BS4 64-0813		G75150T-4	1.50	1.10	100 mm	225
BS4 64-0814		G75165T-4	1.65	1.20	100 mm	190

Premium Corning 8161 (Potash Rubium Lead) Patch Glass

This glass pulls at a lower temperature and is easily shaped. It is recommended for low noise recordings. However, the lead content should be considered for the intended application.

Specifications

Composition	51% PbO, 39% SiO_2, 6% K_2O, 2% BaO
Softening Temperature	600°C
Dielectric Constant	8.3

Premium Corning 8161 (Potash Rubium Lead) Patch Glass

Cat. No.	$	Model	OD mm	ID mm	Length	Qty.
BS4 64-0815		G86150T-4	1.50	1.10	100 mm	225
BS4 64-0816		G86165T-4	1.65	1.20	100 mm	190

For Patch Clamps, see pages H2 to H5.

Clark Capillary Glass

Harvard Apparatus Ltd. Acquires Clark Electromedical Instruments

Clark Electromedical Instruments was acquired by Harvard Apparatus Ltd., Harvard Apparatus' UK subsidiary located in Edenbridge, England. Clark Electromedical Instruments manufactures micro-pipettes and micro-electrodes used primarily in intra-cellular research. Clark Electromedical will continue to trade under the Clark brand name, however, all manufacturing, marketing and sales support has been relocated to the Harvard Apparatus Edenbridge facility.

Discounts on Quantity Puchases:

Discount apply to only single part number quantities (no mixing).

1 to 4	none
5 to 9	5%
10+	10%

Borsilicate Capillaries

- High quality borosilicate glass
- Five outside diameters available
- Available with either thin or standard wall
- Ratio of outside to inside diameters preserved to tip
- Economical

The properties of borosilicate glass make it the most popular material among researchers for the fabrication of electrodes and micro-pipettes. Its low softening temperature combined with its mechanical strength, chemical durability, high electrical resistivity, and its ability to withstand thermal stress, make these capillaries the most widely used in the world. Clark Borosilicate Capillaries are offered in a variety of diameters and wall thickness (standard or thin walled) with or without an inner filament. They are available in fused multi-barrel configurations, as well as in Theta style. Single barrel glass is available in 75 mm (3 in), 100 mm (4 in) and 150 mm (6 in) lengths.

Specifications

Composition	80.9% SiO_2 12.9% B_2O_3 4.4% Na_2O 1.8% Al_2O_3
Softening Temp.	815°C
Dielectric Constant	4.7

Borosilicate Thin Wall without Filament

Borosilicate Thin Wall without Filament

Catalog No.	$	OD	ID	Length	Quantity
BS4 30-0037		1.0 mm	0.78 mm	75 mm	500
BS4 30-0035		1.0 mm	0.78 mm	100 mm	500
BS4 30-0036		1.0 mm	0.78 mm	150 mm	500
BS4 30-0049		1.2 mm	0.94 mm	75 mm	350
BS4 30-0047		1.2 mm	0.94 mm	100 mm	350
BS4 30-0048		1.2 mm	0.94 mm	150 mm	350
BS4 30-0064		1.5 mm	1.17 mm	50 mm	225
BS4 30-0065		1.5 mm	1.17 mm	75 mm	225
BS4 30-0062		1.5 mm	1.17 mm	100 mm	225
BS4 30-0063		1.5 mm	1.17 mm	150 mm	225

Borosilicate Standard Wall without Filament

Borosilicate Standard Wall without Filament

Catalog No.	$	OD	ID	Length	Quantity
BS4 30-0018		1.0 mm	0.58 mm	75 mm	500
BS4 30-0016		1.0 mm	0.58 mm	100 mm	500
BS4 30-0017		1.0 mm	0.58 mm	150 mm	500
BS4 30-0043		1.2 mm	0.69 mm	75 mm	350
BS4 30-0042		1.2 mm	0.69 mm	100 mm	350
BS4 30-0041		1.2 mm	0.69 mm	150 mm	350
BS4 30-0056		1.5 mm	0.86 mm	75 mm	225
BS4 30-0054		1.5 mm	0.86 mm	110 mm	225
BS4 30-0053		1.5 mm	0.86 mm	100 mm	225
BS4 30-0055		1.5 mm	0.86 mm	150 mm	225
BS4 30-0073		2.0 mm	1.16 mm	75 mm	125
BS4 30-0070		2.0 mm	1.16 mm	100 mm	125
BS4 30-0071		2.0 mm	1.16 mm	150 mm	125
BS4 30-0127		3.0 mm	1.62 mm	75 mm	55
BS4 30-0080		3.0 mm	1.62 mm	100 mm	55
BS4 30-0081		3.0 mm	1.62 mm	150 mm	55

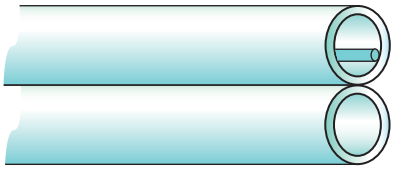
Clark Capillary Glass

Borosilicate with Filament

- Easy filling
- Available in standard or thin wall configurations with selection of three outside diameters
- Exceptionally low tip impedance (less than 50 MΩ)
- Good for patch clamp pipettes and microinjection needles

Borosilicate with Filament					
Catalog No.	$	OD	ID	Length	Quantity
Borosilicate Standard Wall with Filament					
BS4 30-0034		1.0 mm	0.50 mm	75 mm	500
BS4 30-0032		1.0 mm	0.50 mm	100 mm	500
BS4 30-0033		1.0 mm	0.50 mm	150 mm	500
BS4 30-0021		1.0 mm	0.58 mm	75 mm	500
BS4 30-0019		1.0 mm	0.58 mm	100 mm	500
BS4 30-0020		1.0 mm	0.58 mm	150 mm	500
BS4 30-0046		1.2 mm	0.69 mm	75 mm	350
BS4 30-0044		1.2 mm	0.69 mm	100 mm	350
BS4 30-0045		1.2 mm	0.69 mm	150 mm	350
BS4 30-0060		1.5 mm	0.86 mm	75 mm	225
BS4 30-0057		1.5 mm	0.86 mm	100 mm	225
BS4 30-0058		1.5 mm	0.86 mm	150 mm	225
BS4 30-0076		2.0 mm	1.16 mm	75 mm	125
BS4 30-0074		2.0 mm	1.16 mm	100 mm	125
BS4 30-0075		2.0 mm	1.16 mm	150 mm	125
BS4 30-0084		3.0 mm	1.62 mm	75 mm	55
BS4 30-0082		3.0 mm	1.62 mm	100 mm	55
BS4 30-0083		3.0 mm	1.62 mm	150 mm	55
Borosilicate Thin Wall with Filament					
BS4 30-0040		1.0 mm	0.78 mm	75 mm	500
BS4 30-0038		1.0 mm	0.78 mm	100 mm	500
BS4 30-0039		1.0 mm	0.78 mm	150 mm	500
BS4 30-0052		1.2 mm	0.94 mm	75 mm	350
BS4 30-0050		1.2 mm	0.94 mm	100 mm	350
BS4 30-0051		1.2 mm	0.94 mm	150 mm	350
BS4 30-0068		1.5 mm	1.17 mm	75 mm	225
BS4 30-0066		1.5 mm	1.17 mm	100 mm	225
BS4 30-0067		1.5 mm	1.17 mm	150 mm	225
BS4 30-0128		2.0 mm	1.56 mm	75 mm	125
BS4 30-0077		2.0 mm	1.56 mm	100 mm	125
BS4 30-0078		2.0 mm	1.56 mm	150 mm	125

Borosilicate Double Barrel Special



- High quality borosilicate glass
- Special two barrels - one barrel with filament, one without
- Ratio of outside to inside diameter preserved to tip

Borosilicate Double Barrel Special					
Catalog No.	$	OD	ID	Length	Quantity
BS4 30-0004		1.5	0.86 mm	75 mm	100
BS4 30-0005		1.5	0.86 mm	100 mm	100
BS4 30-0006		1.5	0.86 mm	150 mm	100

Borosilicate Theta Glass

- Easy to fill
- Two channels in a single diameter

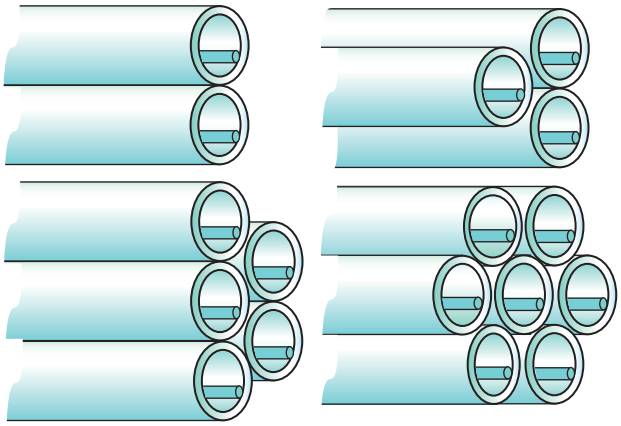
Borosilicate Theta Glass						
Catalog No.	$	OD	Wall	Septum	Length	Quantity
BS4 30-0116		1.5 mm	0.23 mm	0.17 mm	75 mm	100
BS4 30-0114		1.5 mm	0.23 mm	0.17 mm	100 mm	100
BS4 30-0115		1.5 mm	0.23 mm	0.17 mm	150 mm	100
BS4 30-0119		2.0 mm	0.30 mm	0.22 mm	75 mm	100
BS4 30-0117		2.0 mm	0.30 mm	0.22 mm	100 mm	100
BS4 30-0118		2.0 mm	0.30 mm	0.22 mm	150 mm	100

For Microforges, see pages M53 and M54.

For our full line of Pipette Pullers, see pages M51 and M52.

Clark Capillary Glass

Borosilicate Multi-Barrel



- High quality borosilicate glass
- Two, three, five and seven barrel configurations with filament
- Capillaries fused along their full length

Borosilicate Multi-Barrel

Catalog No.	$	OD	Wall	# of Septum	Barrels	Quantity
BS4 30-0003		1.5 mm	0.86 mm	75 mm	2	100
BS4 30-0001		1.5 mm	0.86 mm	100 mm	2	100
BS4 30-0002		1.5 mm	0.86 mm	150 mm	2	100
BS4 30-0007		1.2 mm	0.69 mm	100 mm	3	100
BS4 30-0008		1.2 mm	0.69 mm	150 mm	3	100
BS4 30-0012		1.2 mm	0.69 mm	100 mm	5	65
BS4 30-0013		1.2 mm	0.69 mm	150 mm	5	65
BS4 30-0014		1.0 mm	0.58 mm	100 mm	7	60
BS4 30-0015		1.0 mm	0.58 mm	150 mm	7	60

Borosilicate Glass Rod

- High quality borosilicate glass
- Available in two diameters

Borosilicate Glass Rod

Catalog No.	$	OD	Length	Quantity
BS4 30-0087		1.0 mm	75 mm	500
BS4 30-0085		1.0 mm	100 mm	500
BS4 30-0086		1.0 mm	150 mm	500
BS4 30-0088		2.0 mm	100 mm	125

Aluminosilicate Capillaries

In recent years there has been a developing interest in fabricating micropipettes from aluminosilicate glass. Like silicon, aluminum combines with oxygen to form tetrhbedral networks and the Al-O bonds are very strong. In comparison with borosilicate glass, aluminosilicate provides increased hardness, improved chemical durability, reduced electrical conductivity and a lower coefficient of thermal expansion. Also, while the original ratio of a borosilicate capillary's inner to outer diameter will remain unchanged over its total taper length, aluminosilicate glass demonstrates a marked tendency to thin out as it is drawn to a tip. This behavior allows extremely fine tips to be formed.

For more information, see:

1. Na/H Exchange, Vaughan-Jones, RD.; Grinstein Press, Ch.1 p.8;
2. Effects of intracellular and extracellular pH on contraction in isolated mammalian cardiac muscle, Bountra, C. & Vaughan-Jones, R.D.; Journal of Physiology Volume 418 (1989)

Specifications

Composition	51.9% SiO_2, 22.0% Al_2O_3, 7.8% P_2O_5, 7.7% MgO, 6.9% CaO, 2.1% B_2O_3, 1.4% BaO and 0.2% As_2O_3
Softening Temperature	950°C
Dielectric Constant	6.2

Aluminosilicate Capillaries with Filament

Aluminosilicate Capillaries with Filament

Catalog No.	$	OD	ID	Length	Quantity
BS4 30-0110		1.0 mm	0.53 mm	75 mm	500
BS4 30-0108		1.0 mm	0.53 mm	100 mm	500
BS4 30-0109		1.0 mm	0.53 mm	150 mm	500

Pipette Sterilization and Storage Container

- Ideal for dry heat sterilization of pipettes
- Pyrex-type glass covers make contents easily visible
- Holds 21 pipettes
- Available for 1.0, 1.2, 1.5 and 2 mm diameter pipettes

This container is a convenient and easy to use pipette storage container. It is ideal for both storage and dry heat sterilization of micropipettes. In most application pipettes must be free from contamination at all times. By storing completed pipettes and partially made pipettes (between operations), the complete cleanliness of the micropipettes can be assured. Because the covers are made of Pyrex glass, the complete container with pipettes in-situ can be dry-heat sterilized, ensuring contamination-free pipettes. The base accepts 21 pipettes. Select from containers that holds either 1.0, 1.2, 1.5 or 2 mm OD pipettes.

Catalog No.	$	Product
BS4 69-0114		Pipette Sterilization and Storage Container for 1.0 mm Pipettes
BS4 69-0316		Pipette Sterilization and Storage Container for 1.2 mm Pipettes
BS4 69-0317		Pipette Sterilization and Storage Container for 1.5 mm Pipettes
BS4 69-0318		Pipette Sterilization and Storage Container for 2.0 mm Pipettes

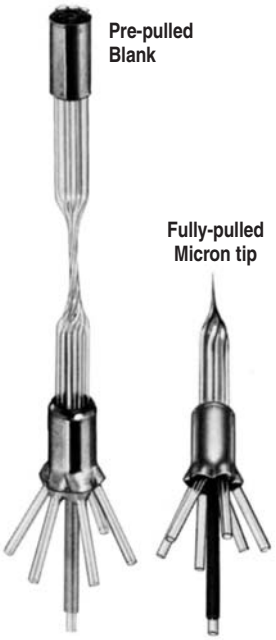
Did you know ?

Harvard Apparatus now owns the Navicyte line of Ussing and Diffusion Chambers. See pages M166 to M170 for complete details on those products and many others.

Did you know ?

Harvard Apparatus now owns Hugo Sachs Elektronik. The HSE isolated organ baths set the industry standard. They can be found in the Isolated Organ and Tissue Section K.

7-Barrel Iontophoresis Micropipette



- Easy filling
- Minimal tip resistance
- Minimal leakage
- Available pre-pulled or fully-pulled

The MS-7P Micropipette has been designed for iontophoretic use as well as pneumatic ejection of drugs. The standard blank consists of seven barrels, pyrex Omegadot tubing, 1.5 mm outer diameter and 1.2 mm inner diameter, pre-pulled to 2 mm formation as shown. The design of the micropipette readily lends itself to electrical connection by inserting Ag wire or to pressure tube attachment for pneumatic use. The overall length of the blank assembly is 10 centimeters. The micropipette is supplied as either pre-pulled blanks or fully-pulled to a micron tip as shown. The micron tip is not bumped and therefore can be finalized prior to use.

Features

- The orifice ratio of each barrel is 0.80 and thus is optimized for minimal tip resistance when pulled to micron size.
- Omegadot tubing permits easy filling.
- Fanned-out outer barrel assembly provides separation thus avoiding leakage due to spills and any cross-coupling between barrels.
- The 22 mm long twisted segment of the blank assembly assures singular tip formation during pulling action thus provides flexibility in a selection of a desired tip configuration.

Cat. No.	$	Model	Micropipettes
BS4 65-0207		MS-7PB	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Pre-Pulled Blank, pkg. of 20
BS4 65-0208		MS-7MT	Micropipette 7-Barrel, 1.5 mm OD Borosilicate Glass, Fully-Pulled, approx. 20 µm Tip, pkg. of 10

For the Neuro Phore BH-2 System for iontophoretic applications, see pages L4 to L8.

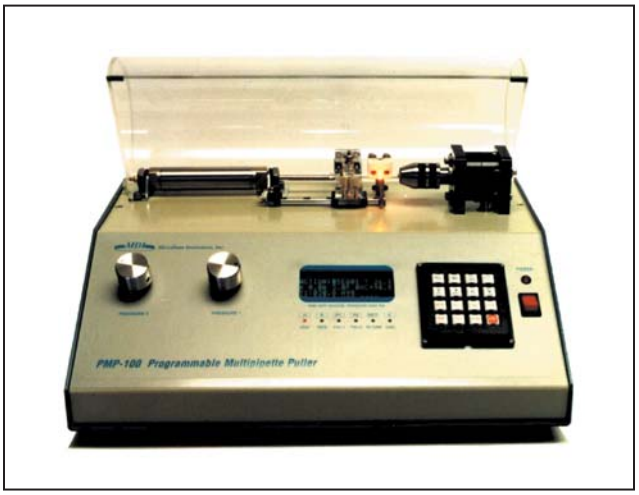
Introduction to Pipettes and Pullers

Needle micropipette fabrication devices include instruments intended to pull, bevel, or forge various types and styles of glass micropipette needles for ICSI, IVF, transgenics, patch recording or other similar procedures involving the use of micropipettes in electrophysiological recording, microinjection, and microperfusion techniques.

The first step in the process involves the initial fabrication of the micropipette itself using either single or multibarrel capillary tubing. This tubing typically ranges in size from between 1 and 2 mm OD and is usually made from borosilicate glass although other materials such as aluminosilicate or quartz are also used in some applications. The capillary tubing is then placed in a micropipette puller where a point on the capillary tubing is brought to its softening point through the use of a heating device such as an electrical filament, laser or gas flame. Once the capillary tubing's softening point temperature is reached, a mechanical parallel pulling force is applied to each end of the capillary tube and it is 'pulled' to the desired tip diameter and profile. Depending on a number of preset variables such as capillary material type, temperature, filment type and pulling force, numerous types of tip profiles and tip diameters can be fabricated. Using this technique tip sizes as small as 0.02 µm can be achieved. Pipette pullers can range in complexity from a simplistic spring/counter weight mechanical puller to highly sophisticated programmable microprocessor controlled pullers.

To reshape the pipette or to fuse the tip into a different geometry, a microforge system is used. A microforge uses a heating element, microscope, illumination, micromanipulators and microtools to change the shape of or contact fuse other elements to the micropipette pipette by heating certain sections of the micropipette to either soften (for bending) or melting (fusing) the micropipette. Some types of microforges can also be fabricate metal and glass microtools.

Harvard Apparatus, Inc. manufactures and sells the complete range of high quality equipment and supplies to fabricate micropipettes.

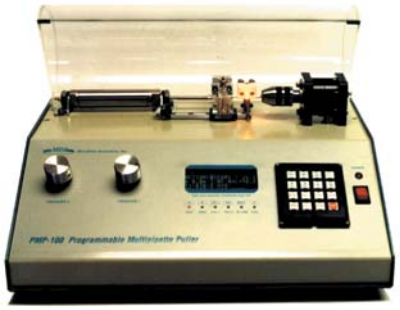


Programmable Pipette Pullers, see page M52

Microforges, pages M53 to M54

For Premium and Clark Capillary Glass, see pages M45 to M49.

Programmable Pipette Pullers



BS4 69-0151

BS4 69-0150

- Two models available:
  - — Single-barrel
  - — Multi-barrel
- Microprocessor controlled system performs programmable multiple step pulling sequences
- Produces micropipettes for patch clamping, intracellular electrodes, injection micropipettes, micro needles, etc.
- Consistent pulling force by utilizing pneumatic pressure instead of gravity or magnetic fields

The PMP-102 is a state of the art microprocessor controlled horizontal pipette puller that has been designed to pull two identical single barrel pipettes at the same time. The pipettes can be used as patch clamp electrodes, intracellular electrodes, injection micropipette or micro-needles.

The PMP-107 is similar to the PMP-102, but is designed to pull a single 4- or 7-barrel pipette. Under program control, the PMP-107 can automatically heat, twist and pull a multi-barrel pipette. There is no need for any manual rotation or any inconsistent timing interrupt control.

Exclusive Optical-Digital Taper Measurement

Instead of a mechanical tip length setting as on other brands of pipette pullers, the PMP-102 and PMP-107 use an exclusive optical-digital ruler to perform precise taper length setting, real-time measuring and controlling. With this feature, a user can handle the taper pulling of pipette tips precisely and very easily. Equipped with a powerful computerized tip sensing function, the PMP-102 and PMP-107 can automatically finish the tip pulling.

Computerized Heater Control

The PMP-102 and PMP-107 use an advanced microcontroller design to perform real-time heater monitoring and pulling control. Thus, they will always provide precise heating power, despite multiple/consecutive pipette pullings or changes in thermal/electrical characteristics.

Programmable Sequences for Creation and Reproduction

There are 25 user programmable pulling sequences with 18 steps in each sequence. Users can start the pulling sequence by just pressing the Start button.

Factory Installed Preset Programs for Major Different Pipette Pulls

Every pipette puller is pre-installed with a number of different pipette pulling programs. With just a few modifications to these steps or parameters new programs can be configured.

Pneumatic Pulling Force

Both pullers use a precise controlled pneumatic pressure as the pulling force rather than gravity or magnetic fields used by other manufacturers. This technique provides more controlled, even, and consistent dragging characteristics allowing the units to pull an ideal injection tip or microelectrode tip easily. A precision micro-linear ball bearing rail and advanced pneumatic components are used to provide no fault pulling movement.

Programming

A simple 4x4 keypad and full information display allows the user to easily control and read all pulling parameters. Programming functions include sequences, steps, time, timing, heater level, heater control, and tip length and actions.

These units are supplied with input tubing and connector, spare heater filament, tweezers, power cord and manual.

Specifications

Pulling Force	Pneumatic
Multi-Barrel Pipette	4- or 7-barrel, BS4 69-0150 only
Each Barrel Pipette	1 mm OD
Heater	Nichrome coil
Heater Control	Microcontroller
Heating	74 general heat levels (24 to 99) 54 auto. heat levels (45 to 98)
Number of Sequences	25
Steps in Each Sequence	18
Taper Length Setting	0.5 to 20 mm
Pressure 1 Regulator	0.1 to 10 p.s.i.
Pressure 2 Regulator	0.1 to 60 p.s.i.
Pressure Gas Input	30 to 60 p.s.i.
Actions	Pull 1, pull 2, pull 2/cool, rotation (BS4 69-0150 only), cool air, return
Display	20 x 4 LCD
Power Input	110/240 VAC
Power Consumption	Max. 150 W
Dimension, H x W x D	17.8 x 27.9 x 35.6 cm
Weight:	
BS4 69-0150	6.8 kg (18 lbs)
BS4 69-0151	5.9 kg (13 lbs)

Catalog No.	$	Product
BS4 69-0150		PMP-107 Programmable Multi-Barrel Pipette Puller
BS4 69-0151		PMP-102 Programmable Single-Barrel Micropipette Puller
BS4 69-0154		Input Tubing with Connector
BS4 69-0155		Output Tubing with Connector and 4.5 ml Vial*
BS4 69-0156		Output Tubing with Connector Only*
BS4 69-0157		Foot Switch*
BS4 69-0158		Remote Key Pad*
BS4 69-0160		Rack Mounting Kits with Handles*
BS4 69-0161		Unpulled 7-Barrel Pipette for BS4 69-0150 Only
BS4 69-0162		Unpulled 4-Barrel Pipette for BS4 69-0150 Only
BS4 69-0165		Pipette Holder for Single-Barrel Pipettes*
BS4 69-0166		Holder for 4-Barrel Pipettes
BS4 69-0167		Holder for 7-Barrel Pipettes

** Note: see page M76 for details.*

De Fonbrune Microforge

Unit shown without Stereo Zoom Microscope

- Combines precise control of both movement and temperature
- Fabricates microtools from simple probes to complex micro-instruments
- Multiple fabrication techniques allow forging/fabricating metals, alloys, organic crystals, polymers and other fusible materials as well as soda lime, borosilicate glass tubing and rod stock
- Air jets provide 'spot' cooling of the heating element

Detail of Electromechanical Forge Assembly

The De Fonbrune is the oldest and most respected name in microforging. The De Fonbrune-type microforge is the latest in a time-honored series based on Dr. De Fonbrune's original device. It complements the precision applications of the de Fonbrune pneumatic micromanipulator, pipette pullers and microinjection systems by producing a wide variety of microtools adaptable to microbiological, cytological, genetic, microsurgical, microphysical and similar investigations and tools as precise as your procedure. It can be used to fabricate a wide range of microtools employing a variety of techniques either separately or in tandem: contact fusion or melting, distant or contact stretching, fracturing, microforging and microglass blowing. Employing a variety of movements and temperature controls, which permit fabrication of microtools from simple to more complex micro-instruments such as, calibrated micropipettes, microscalpels, electrodes and micromanometers (for use in measuring devices for turgor pressure in single cells).

This microforge is an optical-electrical forge system. For superior stability the entire optical-electrical forge assembly is securely bolted to the cast aluminum main housing. This housing contains the transformer, function switches and the operating controls for the adjusting filament temperature and light intensity. A circular disk, or mechanical stage, is mounted in front of the lamp housing. A pivoting spindle cylindrical vice with clamp for supporting the microtool being made is mounted at the periphery of this disk. Both disk and spindle may be rotated about their own axes and precision screws can adjust the entire assembly vertically or horizontally. The light intensity directed to the microscope objectives may also be adjusted. The electrical forge sub-assembly is mounted on an adjustable electrode holder system directly in front of the microscope objectives and to the left of the microtool being fabricated. The spring-loaded filament holder provides for easy insertion or replacement of the platinum-iridium (or other filament material) forge element. The vertical and horizontal position of the heating element can be precisely controlled by the two controls mounted on the operating head and main electrode casting. Two controls on the stage are used to position the vertical and horizontal movement of the microtool.

The electrode holder can be positioned either vertically or horizontally and can easily be replaced. The electrode holder and heating filament can be pivoted as a unit horizontally in a short arc, causing the electrode to move parallel to the optical axis about 1/2 inch. Two curved air jets are also mounted on the adjustable holder system and are equipped with an adjustable valve. These jets direct airflow to the wire-heating filament to provide 'spot' cooling of the heated element. Adjusting the current to the electrode controls filament heat. The heat at a given setting will vary depending on the size and type of filament wire, the amount of air blown against the filament and the amount of heat conducted away from the filament by the tool.

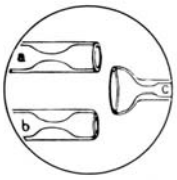
The system is supplied with platinum/iridium wire for the electrode and has the ability to utilize other types and gauges of forging filaments. The apertures of the electrode pins will accommodate up to 22 gauge (0.0253 inch diameter) filament wires. The following items are also included with the system: 4 microtool reamers, wax inducing instrument, capillary glass tubing, hammering rod, 3 sticks sealing cement, 4 80 mm microtool holders, 15-watt bulb, weight set (0.5 to 17 gm in 1 gm increments), 31 ga heating element wire, 1 pkg. 2 x 150 mm pyrex glass rod, forceps and 2 angular microtool holders.

Pipette Pullers

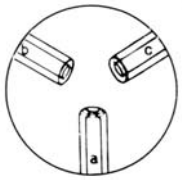
De Fonbrune Microforge

Fabrication Examples

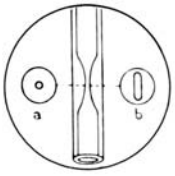
A. Cupping glass: Bent at an angle for positioning in a moist chamber.



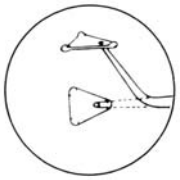
B. Three types of cupping glasses: (a) rounded tip, (b) rounded tip slightly constricted, (c) blown cupping glass.



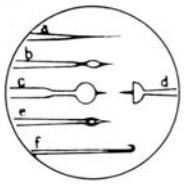
C. Orifices of capillary tubes: (a) Sharp edge, (b) Smooth edge, (c) Constricted orifice.



D. Local constrictions of a capillary tube: A circular (a) or elongated (b) orifice is formed within the capillary.



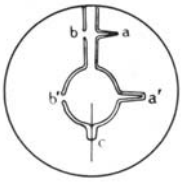
E. Spatula: Piece of triangular glass whose corners have been fire polished and then affixed to a glass rod.



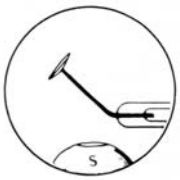
F. Various types of micro-needles; with plain and pediculated points. Hook and needle with eye.

G. Retaining hook.

H. Different types of micro-pipettes: (a, b, c) terminal orifice; (d and e) lateral orifice.



I. Piercing a Glass Wall: a, a', projecting tips; b, b', flat tip; c, passage of a metal wire through an aperture as a'; then sealing it by fusion. A flat plane may be perforated in the same manner.



J. Type of Scalpel: A small globule of glass is affixed to filament. Then a platinum wire embedded in a glass capillary enters the surface of the heated glass. The heat is turned off; instrument pulled away from a circular cutting edge.

K. Spatula loop: Light coming through the opening is darkened by a small film of transparent lacquer.

L. Micro-gauge: The horizontal portion of this gauge is made with a hollow cylinder.

M. Probe (a) and cannula (b).

Specifications

Tool Movement:	
Vertical	12.7 mm (~0.5 in)
Horizontal	10.1 mm (~0.4 in)
Electrode Movement:	
Vertical	7.6 mm (~0.3 in)
Horizontal	15.2 mm (0.6 in)
Focus	12.7 mm (~0.5 in)
Weight	17.25 kg (38 lbs)
Dimensions, H x W x D	38.1 x 27.9 x 40.6 cm (15 x 11 x 16 in), without optics
Power	100/120 VAC, 60 Hz, 220/240 VAC, 50 Hz

Did you know ?

Harvard Apparatus now owns Clark Electromedical. See pages M47 to M49 for the industry standard capillary glass.

Catalog No.	$	Model	Product
BS4 69-0384		MF-1-115	Microforge without Optics, 115 VAC, 60 Hz
BS4 69-0438		MF-1-230	Microforge without Optics, 230 VAC, 50 Hz
Replacement Parts			
BS4 69-0385		MF-2	Electrode Filament Holder
BS4 69-0387		MF-4	Hammering Rod, SS 3/16 x 3.75 in (95 mm) (D x L)
BS4 69-0388		MF-5	Bulb, Frosted for Microforge Illuminator
BS4 69-0389		MF-6	Tool Holder Clamp
BS4 69-0390		MF-7	Fuse, ACG 5, 1/4 x 1-1/4 in
BS4 69-0391		MF-8	Filament Wire, Platinum, 20% IRID, 102 mm (4 in) L, 31 ga, 229 µm (0.009 in) OD
BS4 69-0392		MF-9	Filament Wire, Platinum, 20% IRID, 102 mm (4 in) L, 30 ga, 305 µm (0.012 in) OD
BS4 69-0448		AK15	Glass head pipettes, 3 mm OD, pkg of 100
BS4 69-0394		MF-11	Accessory Kit without weights
BS4 69-0395		MF-12	Filament Holder Assembly with Center Rod, 6.4 x 51 mm (0.25 x 2 in) (OD x L)

MOS 25 & MOS 96 Advanced Electroporation Systems

BTX® HARVARD APPARATUS Molecular Delivery Systems

CE

Features and Benefits

- Methods optimization
- Multi-well plates can be electroporated in less than 10 minutes!
- Integrated electrodes
- Fast and precise molecular delivery
- Rapid and easy experimental optimization
- High throughput approach to experimentation
- Multiple experiments in the sample plate
- Rapid analysis - in a matter of minutes research 96 experimental parameters
- Disposable - For ease-of-use and no carryover

Applications Include:

- Transfection of Mammalian Cells
- Transformation of Bacteria and Yeast
- cDNA Library Screening
- Drug Screening

The Future of Electroporation Is Here!

BTX, the leader in electroporation products and specialty electrodes, has developed a new and innovative product line for experiment optimization and large volume electroporation. The Advanced Electroporation System is a breakthrough in Molecular Delivery. The days of researcher's struggling with tedious, multi-step procedures that typically limited the number of samples and cell types they could test are all about to change.

The Methods Optimization Systems, MOS 25 & MOS 96, allow you to boost your productivity by optimizing your conditions and increasing your yields and viability. The MOS 25 system takes less then 5 minutes to run while the MOS 96 less then 10 minutes! These systems allow the user to quickly and efficiently optimize the electrical and biological parameters associated with any electroporation experiment. Now entire libraries can be screened rapidly and efficiently.

Both the MOS 25 and MOS 96 Advanced Electroporation Systems come complete with disposable multi-well Optimizer Plates, a Plate Handler and an ECM™ 830 Generator, see pages M56 and M57 for complete details on the generator.

Catalog No.	$	Model	Description
BS4 45-0410		MOS 25/200	MOS 25/200 System, includes ECM™ 830 Generator, 6 x 25-Well Optimizer Plates, HT-200 Plate Handler and instructions
BS4 45-0411		MOS 25/100	MOS 25/100 System, includes ECM™ 830 Generator, 6 x 25-Well Optimizer Plates, HT-100 Plate Handler and instructions
BS4 45-0420		MOS 96/200	MOS 96/200 Advanced Electroporation System, includes ECM™ 830 Generator, 2 x 96-Well Advanced EP Plates, HT-200 Plate Handler and instructions
BS4 45-0421		MOS 96/100	MOS 96/100 Advanced Electroporation System, includes ECM™ 830 Generator, 2 x 96-Well Advanced EP Plates, HT-100 Plate Handler and instructions
BS4 45-0452		HT-P96-4	96-Well Disposable Electroporation Plate, with clear bottom, 250 µl capacity per well, 4mm gap
BS4 45-0462		HT-P25-4	25-Well Disposable Optimizer Plate, with clear bottom 250 µl capacity per well, 4mm gap
BS4 45-0401		HT-200	Multi-Well Plate Handler with Auto-Sense Track Switching, includes connectors for standard BTX pulse generators
BS4 45-0400		HT-100	Multi-Well Plate Handler with Manual Track Switching, includes connectors for standard BTX pulse generators
BS4 45-0002		8300	ECM™ 830 Square Wave Electroporation System, see pages M56 and M57
BS4 45-0052		ECM830	ECM™ 830 Generator Only
BS4 45-0001		6300	ECM™ 630 Exponential Decay Wave Electroporation System, see pages M58 and M59
BS4 45-0051		ECM630	ECM™ 630 Generator Only

MOS 25 & MOS 96 Plate Handlers

To complete the MOS 25 Systems there are two plate handlers available, HT-200 and HT-100. The advanced HT-200 Plate Handler features Auto-track sensing which automatically switches columns in the Multi-well plate during electroporation. The Auto-track sensing allows rapid electroporation of an entire plate by setting up the electrical parameters for all columns and pressing one button. The HT-200 is ideal for a busy research laboratory running many daily samples.

The Model HT-100 requires manual switching from column to column and is ideal for laboratories doing basic electroporation research or fewer samples. Both accept either the 96-Well or 25-Well Optimization Plates and provide a safe and reliable working area for processing the Electroporation Plates. Both Plate Handlers have pulse switching technology integrated into the package and gold plated contacts to mate with the Electroporation Plate. The Plate Handlers were designed to operate in space constrained areas such as laminar flow hoods.

Catalog No.	$	Model	Description
BS4 45-0401		HT-200	Multi-Well Plate Handler with Auto-Sense Track Switching, includes connectors for standard BTX pulse generators
BS4 45-0400		HT-100	Multi-Well Plate Handler with Manual Track Switching, includes connectors for standard BTX pulse generators

Call for your local BTX Dealer or visit www.btxonline.com.

NEW ECM® 830 Square Wave Electroporation System

- Superior square wave technology and bipolar pulsing lead to higher viability and efficiency
- Low voltage mode 1 V discrimination and 0.5% accuracy allows for greater reproducibility for low voltage applications such as In Vivo gene therapy, In Ovo gene transfer and nuclear transfer applications
- Monitoring of voltage, pulse duration, pulse interval and pulse number allows for optimization of protocols, troubleshooting and documentation of parameters
- Arc quenching™ minimizes damage caused by arcing
- Generator will not be damaged in the event of a short circuit
- External safety stand protects generator from damage caused by spills or splashes
- All digital user interface design allows for simple operation
- Single rotary dial control simplifies parameter settings
- Voltage Range of 5 V to 3000 V is the basis for a generator capable of electroporating ALL cell types
- Pulse duration range of 10 µs to 10 sec gives unparalleled flexibility for varied applications and optimization range
- Footswitch compatible for hands-free operation

The ECM 830 is a Square Wave Electroporation System designed for all in vitro and in vivo electroporation applications. The generator utilizes the BTX Power Platform Technology and a digital user interface. The ECM 830 possesses key features including finer voltage discrimination and 0.5 V accuracy, Arc Quenching™, the monitoring of all key parameters, and the control of pulse intervals.

Applications

Mammalian Cell Transfections/Gene Therapy

The use of square wave pulses for the transfection of mammalian cells is well established. Fakhrai has used a BTX 800 Series in the technique of Electro-Immuno Therapy.[1] The ECM 830 will enable transfection of mammalian cells while maintaining higher cell viability.[2] For many mammalian cells, higher transfection efficiencies will also be obtained.[3]

Mammalian Cell Protein/Drug Electroincorporation

Square wave pulses have been used to electroincorporate a variety of molecules into mammalian cells; Tsong has used square wave to load drugs into erythrocytes4 while Marrero has used a BTX 800 Series and BTX Model 366 Petri Dish Electrode to incorporate biologically active antibodies into RASM cells.[5]

ECM® 830 Square Wave Electroporation System

In Vivo Applications

Recent advances by BTX have allowed researchers to perform in vivo electroporation. In vivo Electro Gene Therapy has significant advantages over viral mediated gene transfer, biolistics, and the use of cationic Lipids.[6,7,8]

Nuclear Transfer

BTX square wave systems have been used by the experts in mammalian embryo manipulation techniques in nuclear transfer for applications ranging from pharmaceutical production to organ generation.[9,10,11]

Plant Applications

Intact plant tissue and protoplasts may be transformed using electroporation,[12] and references indicate that square wave is indeed superior to exponential decay for plant protoplast transformation.[13]

Bacterial and Yeast Electroporation

The ECM 830 is capable of reproducing 800 Series bacterial protocols, including all four *E. coli* electrotransformation protocols referencing transformation efficiencies equivalent or superior to exponential decay results.[14] Square wave pulses are used to transform yeast species at high efficiencies relative to exponential decay electroporation.[15]

This product meets the requirements of the European Communities (EC), and complies with EMC Directive 89/336/EEC and 73/23/EEC for product safety.

References

1.) *Fakbrai, H. et al., PNAS, 93: 2909- 2914 (1996)*
2.) *Pasco, David, University of Mississippi, Natural Products Center, Personal Communication and Protocols PR0296- 0298, PR0345-349, PR0351-355 (1998)*
3.) *Takahashi, M. et al., Leukemia Research, 15 (6): 507-513 (1991)*
4.) *Tsong, T., et al., Biblthca Haemat, 51: 108-114 (1985)*
5.) *Marrero, M., et al., The Journal of Biological Chemistry, 270 (26): 15734-15738 (1995)*
6.) *Miramatsu et al., International Journal of Molecular Medicine, 1: 55-62 (1998)*
7.) *Nishi, T., et al., Cancer Research, 56: 1050-1055 (1996)*
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9.) *Cambell, K., PPL Therapeutics, Roslin, Scotland, Personal Communication (1998)*
10.) *Cibelli, Jose et al., Science, 280: 1256-1258 (1998)*
11.) *Meng, J., et al., Biology of Reproduction, 57: 454-459 (1997)*
12.) *Lin, C., et al., Plant Physiol. Biochem., 35 (12): 959-968 (1997)*
13.) *Saunders, J., Guide to Electroporation and Electrofusion, 227-247 (1991)*
14.) *BTX Protocols PR0182, PR0183, PR0336, PR0342 (1998)*
15.) *Costaglioli, P., et al., Current Genetics, 27 (1): 26-30 (1994)*

Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Input	110 V/220 V Universal
Charge Time	5 sec maximum (without delay)
Voltage Range:	
LV Mode	5 to 500 V / 1 V resolution
HV Mode	30 to 3000 V / 5 V resolution
Pulse Length Range:	
LV Mode	10 µsec to 999 µsec / 1 µsec resolution
LV Mode	1 msec to 999 msec / 1 msec resolution
LV Mode	1 sec to 10 sec / 0.1 sec resolution
HV Mode	10 to 600 µsec/1 µsec resolution
Voltage dependent/internally controlled	
Multiple Pulsing	1 to 99
Pulse Interval	100 msec - 10 sec
Programmability	Storage for 2 setups (V,t,n,interval)
Arc Control	Arc Quenching™
Safety	Generator short circuit proof
Capacitance	4000 µF
Amperage	500 A limit at 10 msec
Dimensions, H x W x D	14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)
Weight	15 lbs (6.8 kg)
Display	20 x 4 character LCD
Controls	Single Rotary Encoder with push button toggle between all set parameters. Additional on/off Power and Start switches
Monitoring	Monitoring and display of V, t, n, interval
Remote Operation	Footswitch available
Warranty	2 Years

Catalog No.	$	Model	Product
BS4 45-0052		ECM830	ECM 830 Generator (Only)
BS4 45-0002		8300	ECM 830 Electroporation System. Includes ECM 830 Generator (BS4 45-0052), Cuvettes 1 mm, 2 mm, 4 mm, pack of 30 (10 each), Cuvette Safety Stand (BS4 45-0207), and Cuvette Rack (BS4 45-0208)

Call for your local BTX Dealer or visit www.btxonline.com.

NEW ECM® 630 Exponential Decay Wave Electroporation System

CE

- Precision pulse™ provides more reliable and reproducible results
- Over 8300 RC time constants in low voltage mode allows unparalleled performance for precise optimization of plant and mammalian protocols
- 126 RC time constants in high voltage mode allows unparalleled performance for precise optimization of bacteria and yeast protocols
- Low voltage mode: 1 V discrimination allows for greater reproducibility for low voltage applications, including mammalian cell transfections
- 6000 A limit low voltage mode/3000 A limit high voltage mode allows for unparalleled power to drive exclusive BTX specialty electrodes
- Monitoring of peak voltage and time constant for optimization of protocols, troubleshooting and documentation of parameters
- Generator will not be damaged in the event of a short circuit
- External safety stand protects generator from damage caused by spills
- All digital user interface design allows for improved operation
- Single dial control simplifies parameter settings
- Voltage range of 10 to 2500 V is the basis for a generator capable of electroporating all cell types
- Unparalleled resistance range of 25 to 1575 Ω in 25 Ω increments and discrimination in both LV and HV
- Resistance setting on "None" in LV mode reproduce protocols from competitive electroporators with no resistor settings or "unlimited" resistance
- Capacitance Range of 1 µF, 25 µ F to 3275 µF is the widest capacitance range available for low voltage mode applications
- Approximately 400 BTX Protocols simplify electroporation steps
- ECM database with approximately 4000 reference papers give researchers the data needed to develop their own protocols

The ECM 630 is a state of the art exponential decay wave electroporation system designed for in vitro and in vivo electroporation applications. This system incorporates features that make it the most technically advanced exponential decay electroporation system currently available. The generator utilizes the new BTX Power Platform Technology design and novel digital user interface. The revolutionary Precision Pulse™ System provides the researcher unparalleled power in controlling the time constant. With the ability to deliver a maximum of 6000A in the Low Voltage Mode, the ECM 630 is the most powerful generator in its class.

Over 200 ECM 600 protocols may be duplicated with this instrument. The additional ECM 630 resistor selection "none" will allow researchers to reproduce protocols from competitive systems lacking resistor settings or reporting "unlimited" resistance. Indeed, the ECM 630 will perform the widest range of electroporation applications among commercial electroporators on the market.

Application

Mammalian Cell Transfections/Protein/Drug Electroincorporation

Long duration electroporation, consistent with the ECM 630 platform, has resulted in higher expression levels in COS-7, EDR3, DG44, and CV1 cell lines.[1] The ECM 630 will duplicate the five-fold increase in transfection efficiency in comparison to calcium phosphate precipitation for COS-7 reported by Ishmael et al.[2] as well as the murine T Lymphoma results reported by Sundback et al.[3]

Bacterial and Yeast Electroporation

The ECM 630 is the most flexible bacterial and yeast electroporator available and will reproduce protocols by Beggs et al. for *Mycobacterium avium;*[4] Sanders et al. for *Haemophilus influenza* and *Haemophilus somnus;*[5] and Faber et al. for *Hansenula polymorpha.*[6]

ECM® 630 Exponential Decay Wave Electroporation System

Plant Applications

Intact plant tissue and protoplasts may be transformed using the ECM 630, including the species *Agrostis palustris* (creeping bentgrass) and *Lycopersicon esculentum* (tomato),[7] as well as tobacco pollen transformation.[8]

Other Cell Types

Exponential decay electroporation has been demonstrated to be superior to microinjection for medaka oocytes.[9] Yee et al. transfected and expressed firefly Luciferase in *Giardia lamblia.*[10] In addition, Quillan et al. electrotransfected *Xenopus laevis* melanophores and fibroblasts.[11]

Specialty Electrode Applications: The BTX Choice

Takacs et al. directed the electroporation of COS-7 in a 96-well plate format,[12] while Parham et al. optimized transient gene expression in CHO, CV-1, COS-7, HEK 293, and NSO.[13]

Applications

Exponential decay generators may be used for a variety of animal in vivo applications, including drug delivery to pig carotid artery[14] and transdermal delivery of large molecules.[15]

This product meets the requirements of the European Communities (EC), and complies with EMC Directive 89/336/EEC and 73/23/EEC for product safety.

References

1.) *Bodwell et al., Journal of Steroid Biochemistry and Molecular Biology, 68: 77-92 (1999)*
2.) *Ishmael, et al., Journal of Neurochemistry, 67 (4): 1500-1510 (1996)*
3.) *Sundback et al., Journal of of Immunology, 5971-5978 (1998)*
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7.) *Lin et al., Plant Physiology and Biochemistry, 35 (12): 959-968 (1997)*
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Specifications

Operational Status	Internal self test upon start-up
Interface	Digital User Interface
Input	110 V/220 V Universal
Charge Time	5 sec maximum
Voltage Range:	
LV Mode	10 to 500 V / 1 V resolution
HV Mode	50 to 2500 V / 5 V resolution
Capacitance Range:	
LV Mode	1 µF, 25 µF to 3275 µF /25 µF resolution
HV Mode	25 µF, 50 µF
Resistance Range:	
HV & LV Modes	25 Ω-1575 Ω / 25 Ω resolution
LV Mode	"None" setting to simulate alternative systems lacking resistance control
Precision Pulse™:	
LV Mode	Over 8300 RC Time Constants
HV Mode	126 RC Time Constants HV Mode
Safety Short Circuit Proof	Maximum Pulse Delay 10 sec
Amperage:	
LV Mode	6000 A limit
HV Mode	3000 A limit
Dimensions, H x W x D	14 x 31.8 x 31.1 cm (5.5 x 12.5 x 12.25 in)
Weight	10 lbs (4.5 kg)
Display	20 x 4 character LCD
Controls	Single Rotary Encoder with push button toggle between all set parameters. Additional on/off Power and Start switches
Monitoring	Monitoring and display of Vp and RC Time Constant
Warranty	2 Years

Catalog No.	$	Model	Product
BS4 45-0051		ECM630	ECM 630 Generator Only
BS4 45-0001		6300	ECM 630 Electroporation System, Includes ECM 630 Generator (BS4 45-0051), Cuvettes 1 mm, 2 mm, 4 mm, pack of 30 (10 each), Cuvette Safety Stand (BS4 45-0207), and Cuvette Rack (BS4 45-0208)

Call for your local BTX Dealer or visit www.btxonline.com.

NEW ECM® 399 Electroporation System

- "Single-Dial" control is easy to learn and easy to use
- Simple three-step operation: switch on, dial-in voltage and deliver pulse
- LCD digital read-out allows for high resolution display of test parameters
- Displays pulse length and peak voltage that facilitates optimization and troubleshooting
- High and low voltage modes for bacterial and mammalian cells
- Personal cuvette holder is color-coded which reduces the potential for cross contamination
- Compact size saves space and is portable
- Cost effective – an excellent alternative to chemical transfection

The ECM 399 is an electroporation system specifically designed to produce the precise field strengths and pulse lengths required for the transformation of bacterial and yeast cells and transfection of some mammalian cells. The ECM 399 utilizes the BTX Power Platform Technology design and novel digital user interface. The single-dial encoder simplifies the operation of ECM 399. Portable, convenient, and user-friendly are major features of this unit.

Applications

Bacteria/Yeast Transformation

In the High Voltage (HV) Mode, the ECM 399 is optimized to electroporate *E. coli* and other bacteria and yeast for construction of cDNA libraries or mutagenesis.

Mammalian Cell Transfection

In the Low Voltage (LV) Mode, the ECM 399 is designed to deliver a pulse length of approximately 26 msec using the 4mm gap cuvette, at a volume of 400 µl using conductive media such as PBS. This protocol has been found to be ideal for transfection of lymphoid, myeloid, glial, fibroblast and Cos 7 cells.[1] Protocols for these and other mammalian cells can be optimized by varying the voltage and/or the pulse length. Adjusting the voltage adjustment knob varies the voltage, while the pulse length may be changed by varying the sample volume or buffer composition.

This product meets the requirements of the European Communities (EC), and complies with EMC Directive 89/336/EEC and 73/23/EEC for product safety.

Reference

1.) C.Baum et al., "An Optimized Electroporation Protocol Applicable to a Wide Range of Cell Lines", BioTechniques vol. 17(6): 1058-1062, (1994)

Specifications

Operational Status	Internal Self Test Upon Start-up
Interface	Digital User Interface
Charge Time	5 sec maximum
Voltage Range:	
LV Mode	2 to 500 V / 2 V resolution
HV Mode	10 to 2,500 V /10 V resolution
Capacitance:	
LV Mode	1050 µF
HV Mode	36 µF
Resistance:	
LV Mode	150 Ω
HV Mode	150 Ω
Safety	Short circuit and arc proof
Dimensions, H x W x D	10.9 x 23.1 x 19.6 (4.3 x 9.1 x 7.7 in)
Weight	7 lb
Display	16-character LCD backlit
Controls	Single rotary encoder for voltage selection. Additional on/off power and start switches
Monitoring	Monitoring and display of Vp and RC time constant
Warranty	2 Years

Catalog No.	$	Model	Product
BS4 45-0050		ECM399	ECM 399 Generator Only
BS4 45-0000		399	ECM 399 Electroporation System, Includes ECM 399 Generator (BS4 45-0050), Cuvettes 1 mm, 2 mm, 4 mm, pack of 30 (10 each), PEP-BLU (BS4 45-0212), and Cuvette Rack (BS4 45-0208)
BS4 45-0212		PEP-BLU	Personal Electroporation Pak "plug-in" cuvette module

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NEW ECM® 2001

- Versatile Electro Cell Fusion & Electroporation Instrument
- Microprocessor Controlled Precision
- Wide Range of Parameters
- Remote Control

The ECM 2001 is a versatile electro cell manipulation instrument. It generates a proprietary AC wave form for benign dielectrophoretic alignment of cells. With only microsecond switchover time from AC to DC, efficient fusion can take place. After fusion, AC reapplication keeps cells together for the rounding off process. The DC square pulse section can be used as a stand alone powerful electroporation system with a wide range of voltages and pulse lengths capable of operating into low impedance loads.

The 1 MHZ AC pulse aligns cells in real time and saves time (faster) in comparison to PEG. Electrofusion process takes seconds, PEG takes hours. Researchers can change parameters (voltage or time) to get the maximum number of hybrids aligned in "real time." This helps in the alignment of blastomere to oocyte at the correct position for better fusion accuracy for embryo cloning. The researcher is able to watch the fusion process (under microscope) which makes optimization much easier.

The 3000 Volt DC square wave pulse delivers a high voltage square wave electroporation pulse. All 800 Series protocols can be used with this system. The researcher will own two complete systems (electroporation and electrofusion in one) making the ECM 2001 more versatile. A pulse length of 1 - 99 µsec allows for an extensive range of electroporation pulse lengths. The ECM 2001 is the only square wave electroporation system commercially available that allows this range of pulse lengths. The researcher can optimize the experimental conditions to obtain the best results possible.

Post fusion AC pulse allows for compression of the cells following application of the electrofusion pulse. Hybrids do not fall apart, resulting in a higher number of hybrids. The manual start allows for real time visual optimization to obtain maximum number of hybrids. Best results are obtained for fusing blastomere to oocyte for embryo cloning. The automatic start allows the researcher to start the alignment, fusion and compression process by pressing a single button. A remote control allows easy operation of the instrument from outside the hood, while the number of repeats allows for expansion of parameters.

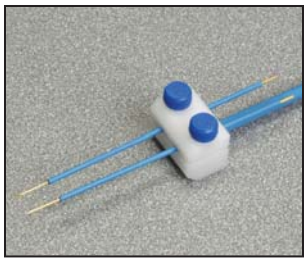
Specifications

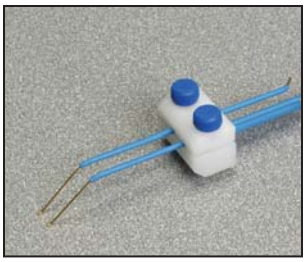
AC Parameters	**(Alignment)**
Proprietary Non-Sinusoidal Wave Shape	
Frequency	1 MHz
Voltage (zero to peak)	0 to 75 V
Duration	0 to 99 sec
Post Fusion AC	1/10 of prefusion
DC Pulse Parameters	**(Fusion/Electroporation)**
High Voltage Mode	
Voltage	10 to 3000 V
Pulse Length	1 to 99 µsec
Low Voltage Mode	
Voltage	10 to 500 V
Pulse Length	0.01 to 0.99 msec
General	
Amplitude	1 to 99 msec
Post Fusion Ramp	1 to 9 sec
Pause between AC / DC	50 µsec
Number of Pulses	1 to 99
Sequence	Automatic or manually controlled
Number of Sequence Repeats	1 to 9
Dimensions, H x W x D	27.9 x 43.2 x 39.4 cm (11 x 17 x 15.5 in)
Warranty	2 years
Power	100/115 VAC, single phase
	230 VAC, single phase
Fuse	7A slow blow
Weight	47 lbs

Catalog No.	$	Model	Product
BS4 45-0053		ECM2001	ECM 2001 Cell Fusion/Embryo Manipulator Generator Only
BS4 45-0003		2001EP	ECM 2001 Electroporation System, Includes 2001 Generator (BS4 45-0053), Cuvettes 1 mm, 2 mm, 4 mm, pack of 30 (10 each), Cuvette Safety Stand (BS4 45-0207), and Cuvette Rack (BS4 45-0208)
BS4 45-0005		2001EM	ECM 2001 Embryo Manipulation System. Includes 2001 Generator (BS4 45-0053), Microslides (BS4 45-0103, BS4 45-0104, BS4 45-0105), Micrograbber Cables (BS4 45-0200, BS4 45-0201), and Coaxial Connection Cable (BS4 45-02103)
BS4 45-0007		2001EF	ECM Electro Cell Fusion System. Includes 2001 Generator (BS4 45-0053), Microslides (BS4 45-0103, BS4 45-0104, BS4 45-0105), Micrograbber Cables (BS4 45-0200, BS4 45-0201), Meander Fusion Chamber (BS4 45-0107), Flat Electrode/Divergent Field (BS4 45-0108), Electrode Adapter (BS4 45-0202), Coaxial Connection Cable (BS4 45-02103), Electroporation chambers, Cuvettes 1 mm, 2 mm, 4 mm, pack of 30 (10 each), Cuvette Safety Stand (BS4 45-0207), and Cuvette Rack (BS4 45-0208)

Electroporation Electrodes

NEW Genetrodes™





The BTX Genetrodes are needle-style reusable electrodes that are used for a variety of applications. Genetrodes come in five models, with each model consisting of a pair of electrodes. The Model 508 and 510 Genetrodes are straight electrodes with gold tips. The Model 512, 514, and 516 Genetrodes are bent L-shaped electrodes with gold tips. These electrodes are connected to a Model 465 Square-Post Micrograbber Cable and interfaced with a pulse generator via a Model 5343 Banana-Coaxial Cable. The Genetrodes may be positioned in parallel at a predetermined gap within a tissue using the Model 515 Genetrode Holder.

General Applications

Genetrodes may be used for many in vivo and in ovo electroporation applications, including drug and gene delivery. The electrodes are placed into a tissue following injection of the molecule of interest, and an electroporation pulse is delivered using a BTX Electroporation System, such as the ECM 830, 2001, and 630. The electric field introduced by the Genetrodes causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into the cells. Genetrodes may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. Properly maintained Genetrodes have a life span of approximately 1500+ pulses and are compatible with most BTX Electroporation Systems.

In Vivo Applications: Model 508 and Model 510

The Model 508 Genetrode with a sharp 5 mm electrode tip is a general in vivo electrode. The Model 510 is the same electrode but with a 10 mm tip. Similar electrodes have been used for a variety of applications. Salford used an electrode of this style with a 600 Series to deliver bleomycin into rat gliomas, doubling animal survival time.[1] Yamaguchi used a similar electrode with an 800 Series to deliver bleomycin into subcutaneously grafted mouse bladder carcinoma, resulting in complete regressions if the tumorous tissue.[2] Nishi used this type of electrode with a BTX Generator to deliver a plasmid DNA construct into rat gliomas, resulting in expression of beta galactosidase in the area between the electrodes.[3] Muramatsu used similar electrodes with a BTX Generator in his studies of LIVGET techniques in mouse testis, concluding that electroporation is superior to microparticle bombardment.[4] Aihara and Miyazaki used these electrodes with an 800 Series to transfer genes into murine muscle tissue, significantly increasing expression levels over DNA injection alone.[5]

In Ovo Applications: Model 512, 514, and 516

The Model 512, 514, and 516 electrodes are all suitable for in ovo gene transfer studies. Funahasi has used an electrode similar to Model 516 with an 800 Series for small-area gene transfer in ovo.[6] An electrode similar to Model 514 has been used with a BTX generator by Muramatsu in his in ovo studies.[7] He concludes that electroporation is superior to both lipofection and microparticle bombardment.[8]

Note: All Genetrode models require Genetrode Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)

Specifications

Voltage Range	0 to 200 V
Pulse Length Range	1 µ sec - 99 msec in PBS
In Vivo Genetrodes	In Vivo Genetrode tips are invasive, gold coated and 0.5 mm in diameter. The shafts are straight and 0.8 mm in diameter
Model 508:	
Electrode Length	5 mm
Shaft Configuration	long
Model 510:	
Electrode Length	10 mm
Shaft Configuration	long
In Ovo Genetrodes	In Ovo Genetrode tips are non-invasive, gold coated and 0.5 mm in diameter. The shafts are 0.8 mm in diameter and L-shaped
Model 512, Electrode Length	5 mm
Model 514, Electrode Length	3 mm
Model 514, Electrode Length	1 mm
Generator Compatibility	ECM 830, 2001 and 630
Genetrode Holder Interelectrode Gaps	1 to 10 mm in 1 mm increments

Catalog No.	$	Model	Product
BS4 45-0113		508	Straight Electrode 5 mm Gold Tip
BS4 45-0114		510	Straight Electrode 10 mm Gold Tip
BS4 45-0115		512	Bent, L-shaped Electrode 5 mm Gold Tip
BS4 45-0116		514	Bent, L-shaped Electrode 3 mm Gold Tip
BS4 45-0117		516	Bent, L-shaped Electrode 1 mm Gold Tip
BS4 45-0203		515	Genetrode Holder
BS4 45-0201		465	Square-Post Micrograbber Cables
BS4 45-0210		5343	Banana-Coaxial Connection Cable
BS4 45-0160		508 KIT	Includes Straight 5 mm Electrode Gold Tip (BS4 45-0113), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)
BS4 45-0161		510 KIT	Includes Straight 10 mm Electrode Gold Tip (BS4 45-0114), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)
BS4 45-0162		512 KIT	Includes Bent, L-shaped 5 mm Electrode Gold Tip (BS4 45-0115), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)
BS4 45-0163		514 KIT	Includes Bent, L-shaped 3 mm Electrode Gold Tip (BS4 45-0116), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)
BS4 45-0164		516 KIT	Includes Bent, L-shaped 1 mm Electrode Gold Tip (BS4 45-0117), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)

References

1.) *Salford et al., Biochemical and Biophysical Research Communications, 194 (2): 938-943 (1993)*

2.) *Yamaguchi et al., J. Exp. Med., 172: 291-293 (1994)*

3.) *Nishi et al., Cancer Research, 56: 1050-1055 (1996)*

4.) *Muramatsu et al., Biochemical and Biophysical Research Communications, 233: 45-49 (1997)*

5.) *Aihara and Miyazaki, Nature Biotechnology, 16: 867-870 (1998)*

7.) *Muramatsu, Mizutani, and Okumura, Anim. Sci. Technol. (Jpn.) 67 (10): 906-909 (1996)*

8.) *Muramatsu et al., Biochemical and BioPhysical Communications, 230: 376-380 (1997)*

NEW Tweezertrodes™

The BTX Tweezertrodes are reusable, tweezer style in vivo electrodes for drug or gene delivery in animals. Tweezertrodes consist of a standard 11.5 cm tweezer that has been modified with stainless steel circular or disk electrodes at the tip. The gap between the electrode disks may be adjusted from under 1 mm to over 2 cm. Tweezertrodes come in two models. Model 520 has an electrode disk diameter of 7 mm and Model 522 has a diameter of 10 mm. Tweezertrodes may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. These electrodes are connected to a pulse generator with the Model 524 Connection Cable, and are compatible with most BTX Electroporation Systems.

Applications

Tweezertrodes may be used for many in vivo applications, including gene and drug delivery. Following localized or systemic injection of the molecule of interest, the Tweezertrode electrode disks are used to grasp the tissue of interest. An electroporation pulse is then given, initiating pore formation and incorporation of the molecule into the cells of the tissue in direct contact with the electrode disks.

Suzuki et al. used Tweezertrodes to deliver a Green Fluorescent Protein (GFP) gene into rat liver. The authors demonstrated successful gene transfer and expression in situ.[1,2]

Tweezertrodes complement BTX Models 508, 510, Caliper Electrode Models 384 and 384L, 2-Needle Array Models 530 and 532 as the newest addition to our in vivo electrode line. The Tweezertrodes can be used to reproduce applications requiring the caliper electrodes, including gene therapy, transdermal drug delivery and electroporation therapy.[3,4,5,6]

References

1.) *Suzuki et al., Direct Gene Transfer into Rat Liver Cells by in vivo Electroporation, FEBS Letters, 425: 436-440 (1998)*

2.) *BTX Electroporation Protocol PR0363 (1998)*

3.) *Zhang, et al., In vivo transdermal delivery of large molecules by pressure-mediated electroincorporation and electroporation: a novel method for drug and gene delivery, Bioelectrochemistry and Bioenergetics, 42: 283-292 (1997)*

4.) *Dev, Giordano and Brown, In vivo delivery of gene to rabbit carotid artery by electroporation, Third U.S./Japan Symposium on Drug Delivery Systems (Abstr.), 38 (1995)*

5.) *Dev, Killing cancer cells with a combination of pulsed electric fields and chemotherapeutic agents, Cancer Watch, 3: 12-14 (1994)*

6.) *BTX Electroporation Therapy Protocols ECT 001 - ECT 005 (1995)*

Specifications

Voltage Range	0 to 1.0 kV
Pulse Length Range	10 µsec to 99 msec in PBS
Model 520:	
Tweezertrode Length	11.5 cm (14.5 in)
Electrode Diameter	7 mm
Electrode Material	Stainless steel
Model 522:	
Tweezertrode Length	11.5 cm (4.5 in)
Electrode Diameter	10 mm
Electrode Material	Stainless steel
Generator Compatibility	ECM T 820, 630, 830, 2001

Catalog No.	$	Model	Product
BS4 45-0118		520	Tweezertrode Electrode 7 mm diameter
BS4 45-0119		522	Tweezertrode Electrode 10 mm diameter
BS4 45-0204		524	Tweezertrode Connection Cable
BS4 45-0165		520 KIT	Includes Tweezertrode 7 mm (BS4 45-0118) and Cable (BS4 45-0204)
BS4 45-0166		522 KIT	Includes Tweezertrode 10 mm (BS4 45-0119) and Cable (BS4 45-0204)

Note: All Tweezertrode models require Connection Cable BS4 45-0204

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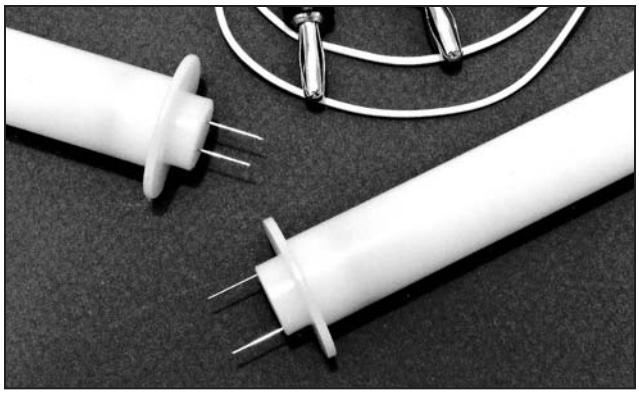
NEW 2-Needle Array™ Electrode



The BTX 2-Needle Array Electrode is an in vivo style electrode specifically designed for muscle gene delivery. The electrode consists of a reusable delrin 2-Needle Array Handle and sterile disposable two-needle array assemblies. The needle array assemblies are conveniently packaged in "Six Packs," allowing for guaranteed sterility and designed to fit conveniently in a sterile hood. The needles themselves are made of medical grade stainless steel.

The 2-Needle Array comes in 5 mm and 10 mm electrode spacings. The Model 530 Handle with the Model 531 10 mm gap 2-needle array assembly are recommended for larger muscle masses, such as rat gastronemus. The Model 532 Handle with Model 533 5 mm gap 2-needle array assembly are recommended for smaller muscle masses, such as mouse tibialis. Other species as well as other tissues may be electroporated with the 2-Needle Array.

Applications

Muscle In vivo Gene Delivery (IVGD)

Among the non-viral techniques for gene transfer in vivo, the direct injection of plasmid DNA into muscle is simple, inexpensive, and safe. Aihara and Miyazaki (1998)[1] showed that by combining electroporation with DNA injection, expression was enhanced 100 fold. Their results demonstrated that gene transfer into muscle by electroporation in vivo is more efficient than intramuscular DNA injection alone. Mir et al. (1999)[2] used various types of electrodes to deliver genes into skeletal muscles of various species (rat, mice, rabbits, monkeys), resulting in 2- to 4-log fold increase in expression. DNA vaccination by direct in vivo administration of plasmid-based DNA vectors has proven to be very effective in animal models. Electroporation enhances gene expression in muscle greatly, making it possible to induce immune response in large animals without using large amounts of DNA. Therefore, in vivo electroporation is proven to be especially useful at increasing effectiveness of DNA vaccinations in large animals.[3]

Other Applications

Electrodes similar to the 2-Needle Array have been used for a variety of applications. Salford used an electrode of this style with a 600 Series to deliver bleomycin into rat gliomas, doubling animal survival time.[4] Yamaguchi used a similar electrode with an 800 Series to deliver bleomycin into subcutaneously grafted mouse bladder carcinoma, resulting in complete regressions of the tumorous tissue.[5] Nishi used this type of electrode with an 800 Series to deliver a plasmid DNA construct into rat gliomas, resulting in expression of beta galactosidase in the area between the electrodes.[6] Muramatsu used similar electrodes with an 800 Series in his studies of LIVGET techniques in mouse testis, concluding that electroporation is superior to microparticle bombardment.[7]

To Use:

While grasping the Needle Array handle, simply position the handle over a needle array assembly and push to secure the needle array onto the handle. Attach the handle to a BTX pulse generator via the high voltage banana cables. Remove the needle safety shield, place into the tissue, and deliver the pulse. Discard the needle array and prepare for the next experiment.

Specifications

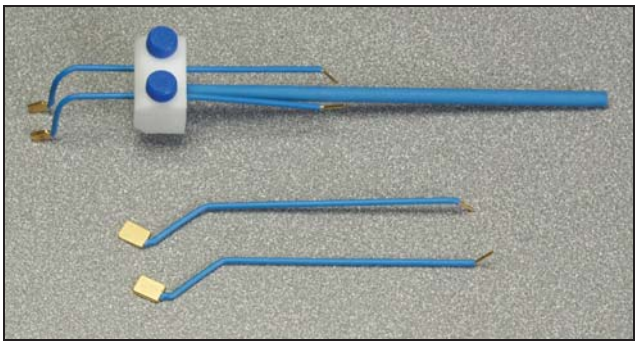
Voltage Range	0 to 500 V
Pulse Length Range	1 µsec to 99 msec in PBS
Electrode Handles	
Model 530:	
Handle Length	8 cm (3.2 in)
Handle Material	Delrin
Electrode Diameter	10 mm
Model 532	
Handle Length	8 cm (3.2 in)
Handle Material	Delrin
Electrode Diameter	5 mm
Two-Needle Array Assemblies	
Model 531:	
Needle Length	20 mm
Needle Material	Stainless Steel
Needle Diameter	10 mm
Model 533:	
Needle Length	20 mm
Needle Material	Stainless Steel
Needle Diameter	5 mm
Generator Compatibility	ECM 830, 630 and 399

Catalog No.	$	Model	Product
BS4 45-0205		530	2-Needle Array Handle 10 mm (requires BS4 45-0120)
BS4 45-0120		531	2-Needle Array 10 mm, pkg. of 6 (requires BS4 45-0205)
BS4 45-0206		532	2-Needle Array Handle 5 mm (requires BS4 45-0121)
BS4 45-0121		533	2-Needle Array 5 mm, pkg. of 6 (requires BS4 45-0206)
BS4 45-0167		530 KIT	Includes 2-Needle Array 10 mm (BS4 45-0120) and Handle 10 mm (BS4 45-0205)
BS4 45-0168		532 KIT	2-Needle Array 5 mm (BS4 45-0121) and Handle 5 mm (BS4 45-0206)

References

1.) *Aihara and Miyazaki, Nature Biotechnology, 16: 867-870 (1998)*
2.) *Mir et al., PNAS, 96-4262-4267 (1999)*
3.) *Personal Communication, Dr. Georg Widera, Genetronics, Inc. (1999)*
4.) *Salford et al., Biochemical and Biophysical Research Communications, 194 (2): 938-943 (1993)*
5.) *Yamaguchi et al., J. Exp. Med., 172:291-293 (1994)*
6.) *Nishi et al., Cancer Research, 56: 1050-1055 (1996)*
7.) *Muramatsu et al., Biochemical and Biophysical Research Communications, 233: 45-49 (1997)*

NEW Genepaddles™



The BTX Genepaddles are paddle-style reusable electrodes suitable for a variety of applications. Genepaddles come in two models, each model consisting of a pair of electrodes. The Model 542 Genepaddles feature rectangular 3 x 5 mm paddles, while the Model 543 Genepaddles feature rectangular 5 x 7 mm paddles. The models vary to suit the size of the target electroporation area. These electrodes are connected to a Model 645 Square-post Cable and interfaced with a pulse generator via a Model 5343 Banana-Coaxial Cable. The Genepaddles may be positioned in parallel at a predetermined gap within a tissue using the Model 515 Genetrode Holder. Genepaddles may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. Properly maintained Genepaddles have a life span of approximately 200+ sets of pulses and are compatible with most BTX Electroporation Systems.

Applications

In Vitro Embryo Gene Delivery

Genepaddles were designed for In Vitro Embryo Gene Delivery (IVEGD) in mouse embryo. The electrodes are placed anterior and posterior to the embryo following injection of the molecule of interest, and an electroporation pulse is delivered using a BTX Electroporation System, such as the ECM 830, 2001, and 630. The electric field introduced by the Genepaddles causes transient pores to form in the cells of the tissue, allowing uptake of the molecules into the cells. Itasaki[1] used a 3 x 5 mm Genepaddle-style electrode with a BTX Generator to deliver DNA to mouse embryo in vitro. His success demonstrates the potential of electroporation to transfect different types of tissues or embryos besides the classical avian embryo.

In Vivio Gene Delivery

Paddle-style electrodes have also been used for in vivo applications. Miyasaka[2] used an electrode of this style with a BTX Generator to deliver DNA in vivo into the cerebral corical anlage of E15 rat embryos. He demonstrated high-efficiency gene transfer into intact neural tissue using electroporation. Electroporation has the benefits of being less labor-intensive and more economical than competitive methods for in vivo gene transfer, such as viral methods and biolistics. Electroporation also produces greater viability and efficiency than competitive methods for in vivo gene transfer.

References

1.) *Itasaki et al., 'Shocking' developments in chick embryology: electroporation and in ovo gene expression , Nature Cell Biology, 1: E203-E207 (1999)*

2.) *Miyasaka et al., Foreign gene expression in an organotypic culture of corical anlage after in vivo electroporation, NeuroReport 10: 2319-2323 (1999)*

Specifications

Voltage Range	0 to 200 V DC (Do not use AC current)
Pulse Length Range	1 to 99 msec in PBS
Pulse Number Range	1 to 99 (depending on voltage and pulse length settings)
Model 542:	
Paddle Dimensions	3 x 5 mm
Paddle Configuration	Rectangular
Paddle Thickness	1 mm
Gold Plating Thickness	0.04 mm
Model 543:	
Paddle Dimensions	3 x 7 mm
Paddle Configuration	Rectangular
Paddle Thickness	1 mm
Gold Plating Thickness	0.04 mm
Generator Compatibility	ECM® 830, 2001 and 630
Genetrode Holder Inter-Electrode Gaps	1 to 10 mm in 1 mm increments

All Genepaddle electrodes are gold plated, noninvasive electrodes.

Catalog No.	$	Model	Product
BS4 45-0122		542	Genepaddles 3 x 5 mm
BS4 45-0123		543	Genepaddles 3 x 7 mm
BS4 45-0203		515	Genetrode Holder
BS4 45-0201		465	Square-Post Cable
BS4 45-0210		5343	Banana-Coaxial Connection Cable
BS4 45-0169		542 KIT	Includes Genepaddle 3 x 5 mm (BS4 45-0122), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)
BS4 45-0170		543 KIT	Includes Genepaddle 3 x 7 mm (BS4 45-0123), Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)

Note: All Genepaddle models require Genetrode Holder (BS4 45-0203), and Cables (BS4 45-0201 and BS4 45-0210)

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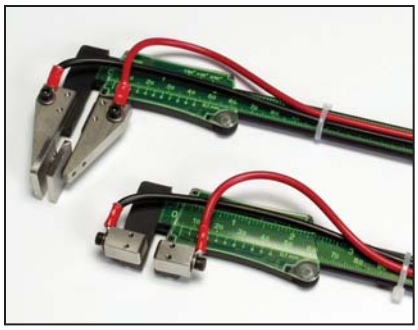
NEW Caliper Electrodes



Specifications Sheet

The BTX Caliper Electrodes are in vivo style re-usable electrodes that are used for a variety of applications. Caliper Electrodes come in two models, with each model consisting of a caliper and a pair of end plates. Model 384 are used for smaller animals with a smaller surface area, while model 384L is used to target slightly larger surface areas. The end plates of the Caliper Electrode may be adjusted by using the black roller mounted on the caliper. Caliper Electrodes may be cleaned with a mild detergent and sterilized with ethanol or ethylene oxide. Properly maintained Caliper Electrodes have an unlimited life, and are compatible with most BTX Electroporation Systems.

Applications

Caliper Electrodes may be used for many electroporation applications, including drug and gene delivery. The electrodes span the target area following injection of the molecule of interest, and electroporation pulses are delivered using a BTX Electroporation System, such as the ECM 630 or ECM 830. The electric field introduced by the Caliper Electrodes cause transient pores to form in the cells of the tissue, allowing uptake of the molecules into the cells. Zhang et al. used the Caliper Electrodes to deliver molecules to skin for gene therapy studies on skin aging.[1] Mir et al. used the Caliper Electrode for in vivo skeletal muscle work[2] as well as subcutaneous tumor electrochemotherapy applications.[3] Caliper Electrodes can potentially be used for intact plant work as well.[4]

Caliper Electrodes complement BTX Tweezertrodes Model 520, 522; BTX Genetrodes Model 508(S) and 510(S); and BTX 2 Needle Array Electrodes Model 530, 531, 532, 533 as part of the BTX in vivo electrode line. Caliper Electrodes can be used to reproduce applications requiring tweezertrodes (transdermal) and Genetrodes/2-Needle Array electrodes (in vivo muscle).

This product meets the requirements of the European Communities (EC), and complies with EMC Directive 89/336/EEC and 73/23/EEC for product safety.

Specifications

Voltage Range	0 to 500 V (depending on electrode gap)
Pulse Length Range	1 µsec to 99 msec (multiple pulsing permitted)
Model 384:	
Electrode Dimensions	1.0 x 1.0 cm
Electrode Material	brass
Model 384L:	
Electrode Dimensions	1.5 cm x 1.5 cm (2.0 cm x 2.0 cm spare pair included)
Electrode Material	stainless steel
Generator Compatibility	ECM 830, 600, 630, T 820
Electrode gap	0.1 to 13 cm

Catalog No	$	Model	Product
BS4 45-0101		384	1.0 x 1.0 cm brass end plates
BS4 45-0102		384L	1.5 x 1.5 cm stainless steel end plates

References

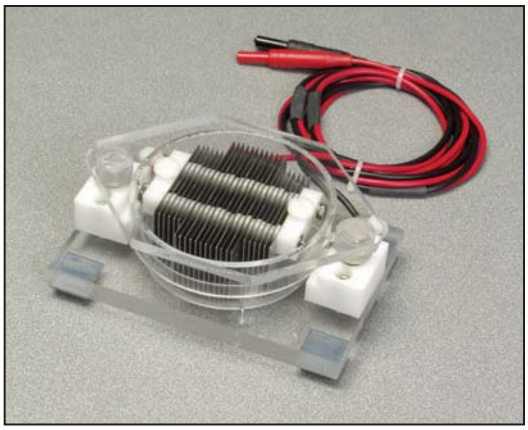
1.) *Zhang, Lei et al., Biochemical and Biophysical Research Communications, 220, 633-635 (1996)*

2.) *Mir et al., PNAS, 96, 4262-4267 (1999)*

3.) *Mir et al., British Journal of Cancer, 77(12), 2336-2342 (1998)*

4.) *Dev et. al, U.S. Patent 5,859,327 Jan 12, 1999*

NEW Petri Dish Electrode



The Petri Dish Electrode is designed to be used with a 100 mm petri dish which functions as the electroporation chamber. To perform electroporation or electrofusion, the samples are placed in the petri dish and the electrode assembly is lowered into the dish. The electrode assembly is available in a 2 mm gap size. It contains parallel stainless steel electrodes which produce homogeneous fields. The electrodes are designed to electroporate volumes ranging from 4 to 50 ml. The Petri Dish Electrode can be used with all BTX electroporation or electrofusion systems.

Applications

The 2 mm gap Petri Dish Electrode can be used for electroporation of tissues grown right in the petri dish. Simply add the exogenous molecule of interest, mix and electroporate.

Catalog No.	$	Model	Product
BS4 45-0100		366	100 mm Petri Dish Electrode, 2 mm gap 50 ml

Call for your local BTX Dealer or visit www.btxonline.com.

NEW Petri Pulser™

The Petri Pulser™ PP35-2P is a reusable electroporation applicator designed to fit into each single well of a 6-well plate or an individual 35 mm diameter petri dish. The PP35-2P consists of an electrode assembly embedded in a polyurethane holder with high voltage electrode cables. The thin electrodes are gold plated and designed to maximize the surface area of electroporation. The high voltage cables are connected with a BTX Pulse Generator, and the electrode head inserted into the dish or well containing the sample. An electroporation pulse may then be delivered. The entire applicator may be cleaned with mild detergent, and the electrodes may be sterilized with ethanol and dried with acetone.

Applications

The Petri pulser PP35-2P is designed for the electroporation of adherent cells in situ or as an alternative to cuvette electroporation for larger volumes or multiple cell samples. The use of the electrode for the electroporation of adherent cells in situ eliminates the need for trypsinization or mechanical removal of cells from their growth substrate. This eliminates associated problems including low plating efficiencies following electroporation, interruption of cell cycle and interruption of intercellular communication.

Mammalian Cell Protein/Drug Electroincorporation

The Petri Pulser PP35-2P supplements our Model 366 Petri Dish Electrode designed for 100 mm petri dishes, as the ideal electrode for in situ electroincorporation of protein into mammalian cells.[1,2,3] This electrode has been used for electroincorporation of peptides and proteins in CHO cells4 and vascular smooth muscle cells.[5]

Mammalian Cell Transfections/Gene Therapy

The Petri Pulser PP35-2P is capable of supporting transfection protocols developed for our larger Model 366 Petri Dish Electrode, including portocols for BHK and HUVEC.[6] The electrode itself has been used for the transfection of 3T3-L1, rat adipose cells, SF295 human neuroglioblastoma and Cos 7 cells.[7]

Plant,Yeast and Bacterial Electroporation Applications

Applications involving plant, yeast and bacterial electroporation may be carried out using the Petri Pulser. Scale up and multiple sample processing.

This product meets the requirements of the European Communities (EC), and complies with EMC Directive 89/336/EEC and 73/23/EEC for product safety.

Specifications

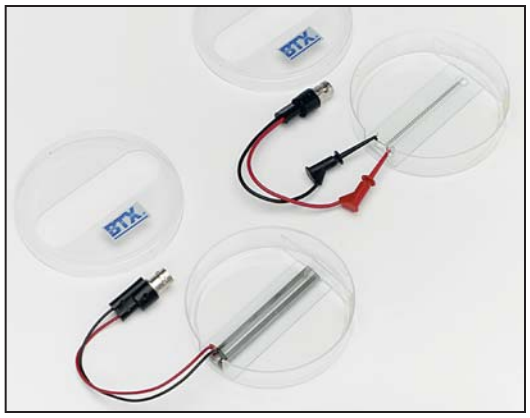
Voltage Range	0 to 300 V	**Electrode Thickness**	0.5 mm
Pulse Length Range	1 to 35 msec in PBS	**Electrode Material**	Gold
Volume Range	0.5 to 3.0 ml	**Generator Compatibility**	ECM 830, 630, 399
Weight	6 oz	**Gap Size**	2 mm
Number of Electrodes	13		

Catalog No.	$	Model	Product
BS4 45-0130		PP35-2P	Petri Pulser Electrode

References

1.) *Marrero et al., Journal of Biological Chemistry, 270 (26): 15734-15738 (1995)*
2.) *Scheiffer et al., Journal of Biological Chemistry, 271 (17): 10329-10333 (1996)*
3.) *Marrero et al., Journal of Biological Chemistry, 272 (39): 24684-24690 (1997)*
4.) *Fukai, Masuko, Emory University, Personal Communication (1998)*
5.) *Fukai, Masuko, Emory University, Personal Communication (1998)*
6.) *BTX Protocols PR0165 and PR0330 (1998)*
7.) *BTX Protocols PR0290, PR00286, PR0359, PR0360, PR0364 (1998)*

NEW Microslides



The BTX Microslides are used primarily with the ECM® 2001 Electro Cell Manipulator. The Microslide fits on the microscope allowing observation of the alignment and fusion process. The Microslide 450 is composed of a glass microslide and two strips of 0.5 mm stainless steel tubing which functions as electrodes to provide a divergent field. These wires are set apart at different gaps to provide various field strengths and volumes. The Micrograbber is used to connect the Microslide 450 to the Coaxial Connection Cable, which will then be hooked up to the ECM 2001 generator. Microslide 453 has two stainless steel square bars that are set apart at various gaps to provide homogeneous fields. The Square Post Cable is used to connect the Microslide to the Coaxial Connection Cable which will be hooked up to the ECM 2001 generator.

Applications

The Microslides have been used for embryo manipulation[1] and cell or protoplast fusion.[2] Advantage of the Microslide is that the process of dimmer formation can be observed under the microscope.

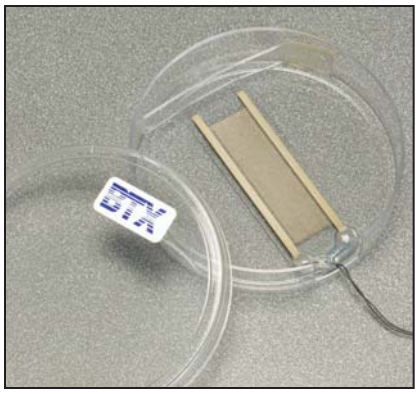
Catalog No.	$	Model	Product
BS4 45-0103		450	Microslide 20 µl, pkg. of 10, 0.5 mm gap
BS4 45-0104		450-1	Microslide 40 µl, pkg. of 10, 1.0 mm gap
BS4 45-0105		453	Microslide 3.2 mm gap, pkg. of 1
BS4 45-0106		453-10	Microslide 10 mm gap, pkg. of 1
BS4 45-0210		5343	Coaxial Banana Plug Connection Cable, 10 ft.
BS4 45-0200		464	Micrograbber Cables, for use with Microslide BS4 45-0103 and BS4 45-0104
BS4 45-0201		465	Square Post Cables, for use with Microslide BS4 45-0105 and BS4 45-0106

References

1.) *BTX Protocol PR0117, Personal communication with Dr. James Robl, University of Massachusetts.*
2.) *Saunders, J.A. and Bates, G.W., Guide to Electroporation and Electrofusion, Academic Press, p. 477-479, 1991*

Electroporation Electrodes

NEW Meander Fusion Chamber



The BTX Meander Fusion Chamber is a microslide with a novel design specifically used for electro cell fusion. This chamber is constructed of a conductive metal alloy which has been deposited in a finger-like projection array on a glass microscope slide. This method of manufacturing creates a highly precise working area. The configuration is designed to give direct viewing of a surface area. This can be used for viewing dimmer formation during alignment while under a microscope. The gaps are set at 0.2 mm.

Application

The Meander Fusion Chamber generates a homogenous field and is used for cell fusion of microorganisms, plant, fungi, yeast and mammalian cells.

Catalog No.	$	Product
BS4 45-0107		Meander Fusion Chamber, product 454, 0.2 mm Gap on Glass Microslide, pkg. of 4 (requires Cables BS4 45-0202 and BS4 45-0210)
BS4 45-0202		Square-Post Micrograbber Cables, product 465
BS4 45-0210		Coaxial Connection Cable, 10 ft, product 461

NEW Flatpack Chambers

Flatpack Chambers are constructed as a new design, featuring a three-ply solid sandwich construction of stainless steel and mylar plastic. Flatpack Chambers are gamma sterilized in individual packages. They are provided in sets of 50 and may be used in the Safety Stand along with the Flatpack Slider.

Applications

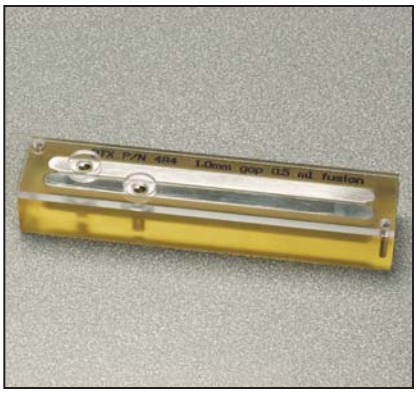
The Flatpack is used for prokaryotic applications. It is a unique flow-through design with a 0.56 mm gap and a volume from 10 to 85 µl. This design provides the unique combination of small sample volumes with field strength as high as 40 kV/cm. Ease of use and safety features required for the high efficiency transformation of certain gram positive organisms, such as E. coli[1].

Catalog No.	$	Product
BS4 45-0109		Flatpack Chambers, product 485, 1.83 mm Gap 1.5 ml, Sterile, pkg. of 50
BS4 45-0110		Flatpack Chambers, product 486, 0.56 mm Gap 80 µl, Sterile, pkg. of 50

Reference

1.) Dr. Steven Mayfield, Scripps Clinic and Research Foundation (Molecular Biology), La Jolla, Californi

NEW Flat Electrode



The Flat Electrode Chambers are made of two rectangular, parallel plates of high grade stainless steel that is press-fitted into a polysulfone base. They generate fields depending on the orientation of the grooved electrodes. Orientating the grooved sides of each electrode so that they face one another generates a divergent field for use in electrofusion experiments. The flat sides of each electrode will generate a homogenous field when facing one another. The Electrode Adaptor is used to attach the Flat Electrode Chamber to the BTX instrument.

Applications

This Flat Electrode Chamber can be used for both electroporation and electrofusion.

Catalog No.	$	Product
BS4 45-0108		Flat Electrode / Divergent or homogeneous field, product 484, 1.0 mm gap; 0.5 ml (requires Electrode Adapter BS4 45-0202 and Cable BS4 45-0210)
BS4 45-0202		Electrode Adapter, product 466, for use with Model 484

Call for your local BTX Dealer or visit www.btxonline.com.

NEW Disposabale Electroporation Cuvettes Plus™ and Safety Stand

- Individually wrapped single use cuvettes expedite experimentation
- Sterile-packaged reduces contamination to important samples
- Transfer pipet allows quick and easy removal of sample
- Color coding for easy cuvette gap identification: Grey 1mm, Blue 2mm,Yellow 4mm
- Round sealing caps allow easy, single-handed cap removal
- Polished aluminum results in lower arcing frequency
- Medical grade polycarbonate is highest quality available
- Three sizes available to suit all applications: 1 mm Bacteria, 2 mm Bacteria, Plant, Mammalian, 4 mm Plant, Mammalian

The BTX Cuvettes Plus are designed for use in electroporation of bacteria, yeast, mammalian, and plant cells. Each sterilized Cuvettes Plus package includes a disposable cuvette and a bonus "pipette" which is used for removal of the sample after electroporation. The cuvettes are molded with embedded aluminum electrodes, washed prior to packaging and gamma irradiated for guaranteed sterility. Three electrode gap sizes are available, 4 mm, 2 mm and 1 mm for high field strengths up to 25.0 kV/cm. Round caps are leak resistant and allow for quick and easy one finger removal. BTX disposable Cuvettes Plus require no maintenance. Simply discard carefully after use. For research use only.

BTX Cuvettes Plus™ Specifications

Catalog No.	BS4 45-0124	BS4 45-0125	BS4 45-0126
Model	610	620	640
Cap Color	Gray	Blue	Yellow
Gap	1.0 mm	2.0 mm	4.0 mm
Field Type	Homogeneous	Homogeneous	Homogeneous
Sample Visibility	Yes	Yes	Yes
Minimum Volume	20 µl	40 µl	80 µl
Maximum Volume	90 µl	400 µl	800 µl
$			

Catalog No.	$	Model	Product
BS4 45-0207		630B	Cuvette Safety Stand (adjustable gap, for use with disposable Cuvettes)
BS4 45-0208		660	Cuvette Rack

NEW Generator Footswitch for ECM® 830

The BTX 1250Fs Footswitch is designed to allow hands-free operation of the ECM® 830 Generator. The footswitch functions identical to the Start button on the front panel of the instrument. Once all the parameters are dialed in, simply press and release the footswitch or Start button to activate pulse delivery or abort a pulse sequence. The BTX Generator Footswitch is designed for used with BTX ECM 830 Square Wave Generator. Versions 1.08 and beyond have software that supports the footswitch operation, so no further modification of the generator is required. If you have a version prior to V1.08, please contact BTX Customer Service and please have the instrument serial number (on the back panel) ready to expedite the process.

Applications

The BTX Generator Footswitch is especially useful when conducting in vivo gene delivery, in ovo gene delivery, and nuclear transfer/cloning applications. These types of experiments often require the researcher to use both hands for other manipulations, generating the need for footswitch activation.

The BTX Generator Footswitch complies with EC Safety Directive, EN61010-1: 1993+A2: 95 for product safety.

Specifications

Dimensions, H x W x D	2 x 4.5 x 3.5 in
Weight	< 2 lb
Cord Length	10 ft

Catalog No.	$	Model	Product
BS4 45-0211		1250S	Footswitch for ECM 830 Generator

Introduction to Microinjection

The use of ***Glass Needle (Fine Glass Microcapillary Pipette)*** *based techniques for intracellular/extracellular microinjection and perfusion has become a popular procedure in numerous areas of experimental biology research (e.g. In vitro fertilization, transgenics, etc.). These techniques can best be described as micro surgical procedures that are conducted on a single cell using either a single or multiple barrel glass micropipette a precision positioning device (micromanipulator) and a microinjector or microperfusor. The micropipettes used in these procedures are formed using a* ***Pipette Puller****. The capillary glass tubing is heated to its softening point and 'pulled' to create the proper size tip diameter and taper for the desired application. The small tip diameters (as low as 0.2 µm) of these micropipettes combined with the high precision of the* ***Micromanipulator*** *and* ***Microinjection/ Perfusion Apparatus****, allows for precise and accurate delivery. This precision allows for accurate and repeatable injections down to the sub-picoliter liter range into or around various types and sizes of cells with accuracy to 0.1 micron. The process of extruding substances through these micropipettes is accomplished through the use of either direct hydrostatic pressure* ***(Pressure Injection)*** *or by moving charged ions that are the result of an applied electric field* ***(Iontophoresis)*** *without the use of hydraulic flow.*

Applications of microinjection range from assisted (In vitro) cell fertilization techniques to the transport of molecular and cellular elements. These substances are typically injected into the cell to manipulate and/or monitor the fundamental biochemistry of a specific living cell. Substance that can be injected include, cellular organelles, kinases, histochemical markers (such as horseradish peroxidase or lucifer yellow), proteins, metabolites, microbeads, ions, antibodies, genes, molecular biology mRNA and DNA, etc. The precise delivery (microperfusion) of small volumes (picoliter to milliliter) of various agents and drugs to a cell or group of cells for applications such as pharmacological drug testing can also be accomplished using these techniques.

In order for the researcher to conduct any of the above experiments and get meaningful results, the tools (equipment) used in these experiments must provide not only the specific functionality, but they also need to be of the highest quality and provide the necessary reliability, accuracy and repeatability to insure proper results. Harvard Apparatus, Inc. manufactures and sells the complete range of product that are needed to successfully microinject and/or microperfuse.

Warner and Harvard Apparatus Clark Capillary Glass, pages M45 to M49

Pipette Pullers, pages M51 and M52

Micromanipulators, pages M186 to M201

Harvard Apparatus/ Medical Systems Picoliter Injectors, pages M71 and M72

Harvard/ Apparatus Medical Systems NeuroPhore, pages L2 to L8

Pressure Injection Systems, pages M75 and M76

Harvard/Medical Systems PLI-100 Pico-Injector

BS4 65-0001 PLI-100 Pico-Injector

- 5 pressures: inject, balance, clear, fill and hold
- Reliable
- Femtoliter to microliters
- Reproducible
- Easy to use
- Popular applications:
  - Injection of mouse, frog, zebrafish and other oocytes
  - Extracellular brain injections
  - Injection of DNA, mRNA, microbeads, neurotransmitters, kinases and other proteins
- Most Published Injector

The PLI-100 Pico-Injector reliably delivers a wide range of volumes through micropipettes by applying a regulated pressure for a digitally set period of time. Compressed gas allows the user to deliver desired volumes from femtoliters to microliters while simultaneously holding a cell. Whether you need to do large injections into capillaries or very small injections into mammalian nuclei, the PLI-100 is well suited for your experiment.

The PLI-100 has become a favorite of prestigious national microinjection workshops like Cold Spring Harbor Laboratories and other researchers worldwide. Other companies have tried to design similar systems, but the PLI-100 remains unparalleled in terms of ease of use, durability, precision, and cost.

Researchers Say:

"The PLI-100 is very robust, in constant use in our lab."

"Most importantly, the PLI-100 valves prevent cytosol and yolk backflow into my pipette after oocyte injection."

"It's very easy to control."

"The PLI-100 is heavily used on a daily basis, and works great."

"I like the fact that I can use the PLI-100 with TTL pulses."

"It works great in conjunction with my imaging system."

"The balance pressure is a good option."

"My injection pipettes rarely clog."

Easy to Use

Inject with the touch of a button or a tap of the foot switch — it's as easy as that!

Reproducible

Pressure to the pipette is controlled precisely through a multi-turn regulator, and is reported digitally for easy repeat. Injection time is digitally controlled in 10 msec steps between 0.01 to 0.99 seconds (and in 1 second steps between 1 to 99 seconds). Pipette tip diameter, and hence delivered volume, are easy determinations once the timing and pressure are known.

Versatile

Deliver volumes from femtoliters to microliters with the same instrument, resulting in a wide range of applications.

Pressure Capabilities

The PLI-100 features two negative and three positive pressure pneumatic capabilities.

The negative, or vacuum functions allow the user to:

1. Fill micropipettes from their tips, reducing wastage of valuable injectables.
2. Provide a means to secure and manipulate a cell using a holding pipette.

The positive pressures allow the user to:

1. Eject precise amounts of fluids.
2. Create a balance pressure which prevents backflow into the micropipette following an injection.
3. Clear a micropipette of material in it.

Unique Features

The PLI-100's important 'Balance', 'Hold' and 'Clear' functions are features not found on other microinjection units.

Balance

In addition to the ejection pressure, the Pico-Injector offers a secondary balance pressure. This adjustable pressure keeps a positive pressure on the injection pipette before and after injections. This eliminates dilution caused by capillary action and aids in the prevention of clogging. Wasteful continuous injection, which often occurs when no separate balance pressure is offered by an injection device, is avoided.

Fill/Hold

There are two built-in vacuum generators to fill a micropipette from the tip and to hold suspended cells. Filling the pipette from the tip is easier than back filling. Suspended cells can be held with a second (holding) pipette. The holding vacuum's range accommodates most cell types.

Clear

A high-pressure pulse can be used for clearing a pipette, should it happen to clog. This is particularly useful when working with pipettes sized for smaller volumes.

Electrical Connectors

BNC type connectors are available at the front panel to ease integrating the Pico-Injector with other equipment. Synchronization of injections to other stimulations or recordings is therefore possible.

Selection Guidelines

The PLI-100 is available in three packages: Plus, Basic and Deluxe. The basic unit is supplied with an input hose, output hose, holding hose, power cord and instruction manual. The plus unit also includes a foot switch, pipette holder and input hose adapter. The deluxe unit includes all the previously mentioned accessories plus an additional foot switch and one pipette holder.

For Clark Electromedical Capillary Glass, see pages M47 to M49.

Harvard/Medical Systems PLI-100 Pico-Injector

Specifications

Input Gas Pressure	70 to 105 p.s.i. (480 to 720 kPa)
Injection Pressure	0.2 to 60 p.s.i. (413 kPa), regulated, multi-turn control
Balance Pressure	0.1 to 3.5 p.s.i. (68.9 kPa), regulated, multi-turn control, other ranges available upon request
Fill Vacuum	Internally produced, -12.0 p.s.i. (-82 kPa), unregulated
Holding Vacuum	Internally produced, 0 to 3 in H_2O (0 to 0.75 kPa or 0 to 0.1 p.s.i.), regulated
Clearing Pressure	Input gas pressure, unregulated
Injection Timer 1 sec steps **Pulse Width**	0.01 to 0.99 sec in 10 msec steps; 1 to 99 sec in
Injection Count Display	Digital, 0 through 9999
Duration Mode	Internally timed or externally gated
Time Trigger	Front panel, foot switch, or external TTL pulse (BNC)
Pressure Units	p.s.i./kPa; switch selectable
Pressure Monitor	BNC connector, 10 mV/p.s.i.
Pressure Readout	Inject, balance, clear, output port
Line Voltage	100/110/220/240 VAC
Power Usage	220 W
Meter Accuracy	0.1% full scale
Foot Switches	Inject, fill, hold, and gated; provided in plus and deluxe pkgs.
Weight	6.8 kg (15 lb)
Dimensions, H x W x D	11 x 38 x 25.5 cm (5 x 15 x 10 in)
Accessories Supplied	Input, output and holding hoses

Catalog No.	$	Model	Product
BS4 65-0001		PLI-100	PLI-100 Basic Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, Power Cord and Instruction Manual
BS4 65-0002		PLI-100 Plus	PLI-100 Plus Pico Injector with Injection, Balance, Clear, Filling and Holding Pressures; Comes with Input Hose, Output Hose, Holding Hose, Power Cord, Instruction Manual, Foot Switch, Pipette Holder and Input Hose Adapter
BS4 65-0003		PLI-100 Deluxe	PLI-100 Deluxe Pico-Injector with Injection, Balance, Clear, Filling and Holding Pressures, Comes with Input Hose, Output Hose, Holding Hose, Power Cord, Instruction Manual, Two Foot Switches, Two Pipette Holders and Input Hose Adapter

Harvard/Medical Systems PLI-90 Picoliter Injector

BS4 65-0004 PLI-90 Pico-Injector

- 3 pressures — inject, balance, and clearing
- Eliminates backflow into pipette after injection
- Reproducibly delivers femtoliters to microliters
- Easy to use
- Economical
- Precise

The PLI-90 Pico-Injector, like the reliable PLI-100 Pico-Injector, see following pages, controls the precise and reproducible regulation of injection pressure and time.

Simplicity

Because the PLI-90 features only the injection, balance, and clearing positive pressures, it is a lower cost alternative to the PLI-100. This simplicity makes it even easier to use than the PLI-100.

Selection Guidelines

The PLI-90 is ideal for the user who does not require vacuum for filling pipette barrels or if using a holding pipette for holding cells is not essential to your application.

The PLI-90 is available in two packages: Basic and Plus. The basic includes an input and output hose, handle, power cord and instruction manual. The plus model is supplied with all of the same parts as the basic model but also includes a Footswitch, Pipette Holder, and Input Hose Adapter

Specifications

Input Gas Pressure	70 to 105 p.s.i. (480 to 720 kPa)
Injection Pressure	0.2 to 60 p.s.i. (413 kPa), regulated, multi-turn control
Balance Pressure	0.1 to 3.5 p.s.i. (68.9 kPa), regulated, multi-turn control, other ranges available upon request
Clearing Pressure	Input gas pressure, unregulated
Injection Time	0.01 to 0.99 sec in 10 msec steps; 1 to 99 sec in 1 sec steps
Pressure Display	Digital, three and a half digits
Duration Mode	Internally timed or externally triggered
Trigger Mode	Foot or panel switch
Pressure Readout	Inject, balance, clear, output port
Line Voltage	100/110/220/240 VAC
Power Usage	220 W
Foot Switch(es)	Optional inject and gating
Accessories Supplied	Input hose, output hose and power cord
Weight	6.8 kg (15 lb)
Dimensions, H x W x D	11 x 38 x 25.5 x cm (5 x 15 x 10 in)

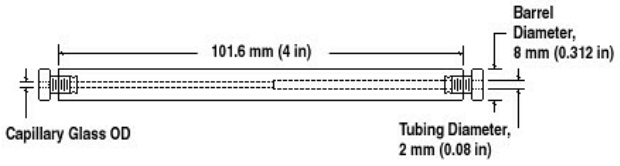
Catalog No.	$	Model	Product
BS4 65-0004		PLI-90 BASIC	Pico-Injector with Injection, Balance and Clear Pressures; Includes Input Hose (PLI-IHN) and Output Hose (PLI-OHN), Handle, Power Cord and Inustruction Manual. Applications: Basic setups that do not need suction.
BS4 65-0005		PLI-90 PLUS	Pico-Injector Basic Model and Acces-sories (Shown Above), Plus One Each PLI-FS Foot Switch, PLI-PH1 Pipette Holder and PLI-IHA Input Hose Adapter

Harvard/Medical Systems PLI-100 and PLI-90 Accessories

Catalog No.	$	Model	Product
Accessories			
BS4 65-0029		PLI-FS	Footswitch for Inject, Hold, Fill or Gate (Order more than one if frequent use of footswitch is needed for more than one of these functions.)
BS4 65-0030		PLI-RM	Frame to Mount PLI-90 or PLI-100 in 19-in. Wide Instrument Rack
Hosing			
BS4 65-0006		PLI-IHA	Input Hose Adapter (1/4 in Male BS4T Pipe Thread) Gas Bottle Regulator Fitting; Connects with PLI-IHO/N
BS4 65-0007		PLI-IHO	Gas Input Hose (Tygon Tubing), 9 ft x 0.250 in (6.35 mm) x 0.125 in (3.18 mm) x 0.062 in (1.57 mm) (L x OD x ID x Wall Thickness); Connects to PLI-IHA and PLI 90/100 Gas Input, Brass Screw Fitting Type - Old
BS4 65-0008		PLI-IHN	Gas Input Hose (Tygon Tubing) 9 ft L x 0.250 in (6.35 mm) OD x 0.125 in (3.18 mm) ID x 0.062 in (1.57 mm) Wall Thickness; Connects to PLI-IHA and PLI 90/100 Gas Input, Quick Connect/Disconnect Type - New
BS4 65-0009		PLI-OHO	Output Hose (Tygon Tubing) 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders, Brass Screw Fitting Type - Old
BS4 65-0010		PLI-OHN	Output Hose (Tygon Tubing) 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders and PLI 90/100 Gas Output, Quick Connect/Disconnect Type - New
BS4 65-0011		PLI-HHO	Holding Hose with Cell Release Bulb; 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness; Connects to MSC Pipette Holders and PLI-100 Hold Output, Brass Screw Fitting Type - Old
BS4 65-0012		PLI-HHN	Holding Hose with Cell Release Bulb; 9 ft L x 0.071 in (1.80 mm) OD x 0.039 in (1 mm) ID x 0.016 in (0.41 mm) Wall Thickness. Connects to MSC Pipette Holders and PLI-100 Hold Output, Quick Connect/Disconnect Type - New

Catalog No.	$	Model	Product
Pipette Holder/Adapter/Parts			
BS4 65-0013		PLI-PH1	Stainless Steel Pipette Holder, 130 mm L for 1 to 1.5 mm OD Glass Pipettes
BS4 65-0014		PLI-PH1A	Stainless Steel Pipette Holder, 80 mm L for 1 to 1.5 mm OD Glass Pipettes
BS4 65-0017		PLI-SRG	Silicone Rubber Gasket Replacement for use with PLI-PH1 and PLI-PH1A, 10.2 cm (12 in)
BS4 65-0015		PLI-SRG1.5	Silicone Rubber Gasket Replacement for use with 1.5 mm Glass Pipettes
BS4 65-0018		PLI-SSB	Stainless Steel Bushing Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
BS4 65-0019		PLI-PC	Stainless Steel Pipette Cap Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
BS4 65-0020		PLI-HN	Stainless Steel Hose Nut Replacement for use with PLI-PH1 and PLI-PH1A Pipette Holders
BS4 65-0021		PLI-PH-KIT	Pipette Holder Hardware Replacement Kit for use with PLI-PH1 and PLI-PH1A Pipette Holders, Includes 1 each PLI-SSB, PLI-PC, PLI-HN and PLI-SRG
BS4 65-0022		PLI-PHA	Stainless Steel Pipette Holder (PLI-PH series) Adapter for Eppendorf ECET FEMTOTIP

Optional "Easy Insert" Acrylic Pipette Holder

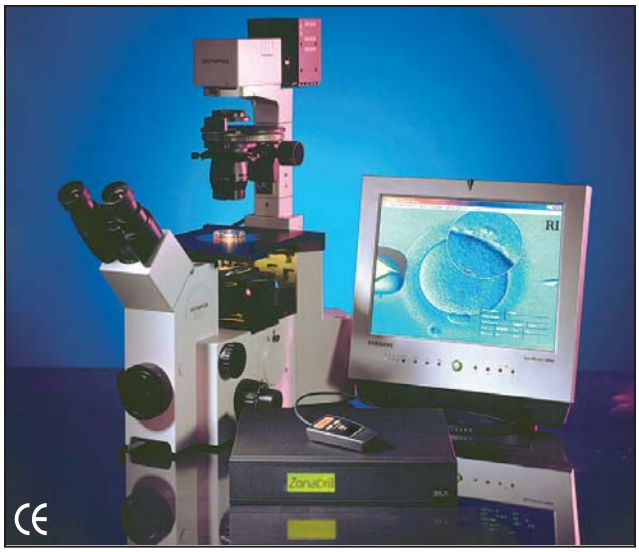


Catalog No.	$	Model	Product
BS4 69-0867		AO16 1.0	Acrylic Pipette Holder for 1.0 mm Pipettes
BS4 69-0868		AO16 1.2	Acrylic Pipette Holder for 1.2 mm Pipettes
BS4 65-0023		PLI-PPH	Acrylic Pipette Holder for 1.5 mm Pipettes
BS4 69-0869		AO16 1.2	Acrylic Pipette Holder for 2 mm Pipettes

Did you know? **Harvard Apparatus now owns Clark Electromedical. See pages M45 to M49 for industry standard capillary glass.**

Did you know? **Harvard Apparatus now owns the NaviCyte line of Ussing and Diffusion Chambers. See pages M166 to M170 for complete details on those products and many others.**

NEW ZonaDrill™



- High transmission optics for reduced laser pulse time
- Non-contact laser
- Mercury free Zona removal
- Digital display
- Easy to use and install

The New ZonaDrill™ is a class 1 Laser System that incorporates the latest in fiber optic technology to provide the most compact laser system currently available. The ZonaDrill™ laser system is mounted via the epifluorescence port or side port of all popular brands of inverted microscope. It can also be used in conjunction with all brands of micromanipulators and microscopes.

Rapid Zona removal is possible using the non-contact laser. Laser ablation is much faster than mechanical methods such as piezo electric devices and manual micromanipulation. Improve your efficiency and effectiveness in the lab with this market leading product.

A visible pilot laser is used to target the main invisible ablation laser and the digital display informs the user when the laser is primed and ready to fire. The pulse duration of the laser is adjusted according to the hole size required. The new digital display and compact hand control are unique features of this Laser system allowing easy and quick operation of the laser.

The latest ZonaDrill™ laser system now incorporates a new laser objective which provides a very high quality, high resolution image. It has also been designed for high transmission of the laser so that shorter pulse times are needed to ablate the zona, resulting in increased embryo viability.

The ZonaDrill™ is the safest laser on the market today and is 100% accurate guaranteed. The Unique Safety Circles, based on independent medical research, gives the user a visual indication of the Safety Zone for the protection of critical cells. This laser system features a unique hand-held control, a pilot laser targeting system and a digitally controlled pulse time. Additionally, the ZonaDrill™ requires no special needles/pipettes and is portable between microscopes.

Use ZonaDrill™ for trouble free Cell Nuclear Transfer, ICSI and stem cell removal. ZonaDrill™ can also be used in conjunction with fluorescence.

Available with the Cronus software suite for cell/embryo analysis and digital target generator.

Specifications

Ultra Focused Laser Beam:	
Solid State Diode Laser	1480 nm/300 mW
Power Density at Focus	4.5 mW/cm
Laser Focus Diameter	2 µm
Non-Mercury	
Pilot Laser	635 nm Spot Targeting Solid State Diode Laser
Objective Lens	40X

Catalog No.	$	Product
BS4 72-6475		ZonaDrill™ for Olympus IX50 / IX70
BS4 72-6476		ZonaDrill™ for Olympus IX51 / IX71 / IX81
BS4 72-6477		ZonaDrill™ for Nikon Eclipse TE 200/300
BS4 72-6478		ZonaDrill™ for Nikon Eclipse TE 2000
BS4 72-6479		ZonaDrill™ for Nikon Diaphot 200/300
BS4 72-6480		ZonaDrill™ for Zeiss Axiovert 200
BS4 72-6481		ZonaDrill™ for Zeiss Axiovert 100/135
BS4 72-6482		ZonaDrill™ for Leica DMIRB

Multi-Channel Pressure Injection Systems

BS4 69-0153 8-Channel Pressure Injection System

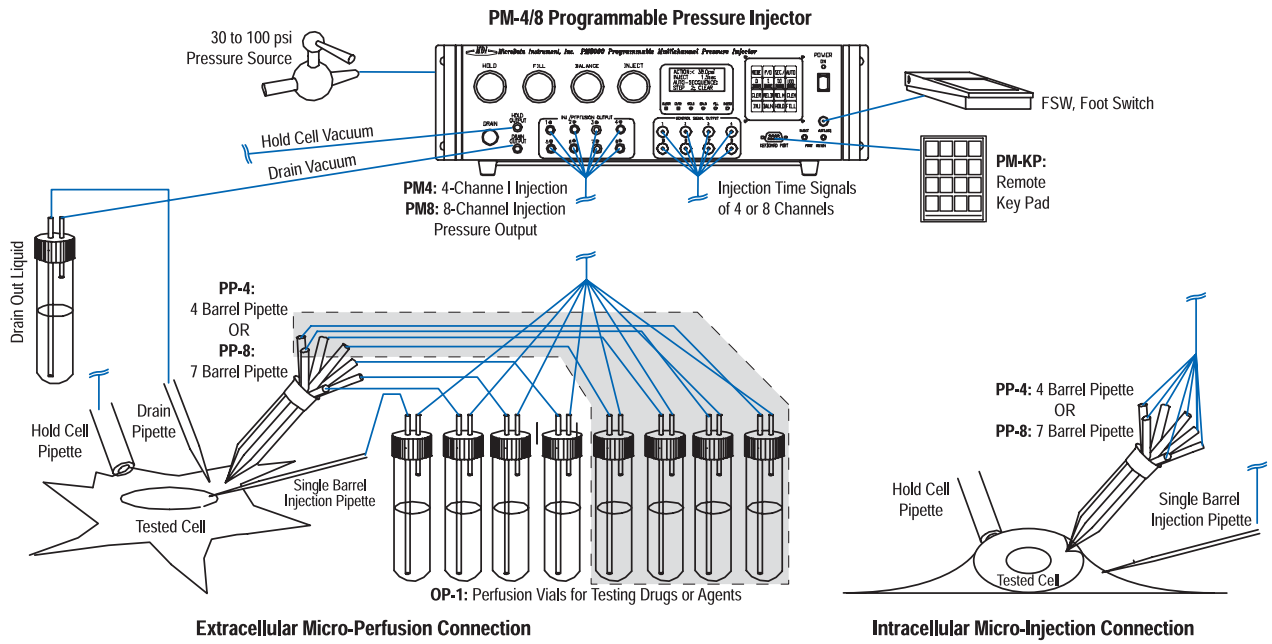
- Multiple function system for micro-injection and perfusion
- Up to 8 injection/perfusion outputs, one hold cell output and one synchronized drain out channel
- Programmable timers, counters and step sequences which can be stored for reuse
- Manual control or automatic sequential step cycle operation
- Front panel display for pressures and programming information

The PM-4 and PM-8 programmable 4 and 8-Channel Pressure Injector systems are designed for one to eight channel intracellular injection and extracellular perfusion. These microinjection and perfusion engines are especially designed for pharmacological drug testing, molecular biological DNA, RNA transferring, intracytoplasmic sperm injection and cell electrophysiological applications.

Combining an advanced microcontroller with precision pneumatic components, these systems can simultaneously control up to eight injection micropipettes or eight perfusion vials and one cell holding pipette and one drain pipette. The four (PM-4) or eight (PM-8) injection/perfusion output ports can be controlled separately or combined together to perform actions such as injection, capillary action balancing, suction or clear up. The cell holding output port can produce an adjusted gentle suction to hold a cell, eject a pressure to push a cell, or completely clear the holding pipette. Another drain output port can simultaneously produce an adjusted suction to drain and clear out liquid before the next channel micro-perfusion. The PM-4/8 can deliver different quantity agents and drugs from picoliters to continuous perfusion. All output pressures and vacuums can be regulated and can be displayed real-time on the front panel display. Previous pressure readings can also be recovered on the display for setting comparison.

Besides programmable timers and counters, there are 16 programmable and savable injection/perfusion sequences with 32 programmable steps in each sequence. Each sequence can be repeated continuously or triggered manually. The interval time between steps can be programmed for automatic sequential cycle or manual trigger. There are two foot switch connectors for sequential step trigger and injection trigger. A digital remote port can be connected to an optional remote key pad or be controlled by a computer. With exceptional versatility and extremely precise control, either the PM-4 or 8 is an ideal multi-channel injection/perfusion engine.

Connection Diagram for Extracellular Micro-Perfusion and Intracellular Micro-Injection Systems


PM-4/8 Programmable Pressure Injector
30 to 100 psi Pressure Source
Hold Cell Vacuum
Drain Vacuum
PM4: 4-Channe l Injection
PM8: 8-Channel Injection Pressure Output
Injection Time Signals of 4 or 8 Channels
FSW, Foot Switch
PM-KP: Remote Key Pad
Drain Out Liquid
PP-4: 4 Barrel Pipette OR PP-8: 7 Barrel Pipette
Hold Cell Pipette
Drain Pipette
Single Barrel Injection Pipette
Tested Cell
OP-1: Perfusion Vials for Testing Drugs or Agents
Extracellular Micro-Perfusion Connection
PP-4: 4 Barrel Pipette OR PP-8: 7 Barrel Pipette
Hold Cell Pipette
Single Barrel Injection Pipette
Tested Cell
Intracellular Micro-Injection Connection

Multi-Channel Pressure Injection Systems

BS4 69-0152 4-Channel Pressure Injection System

Cat. No.	$	Qty	Model	Product
BS4 69-0152		1	PM4	4-Channel Pressure Injection System*
BS4 69-0153		1	PM8	8-Channel Pressure Injection System*
BS4 69-0155			OP1	Output Tubing with Connector and 4.5 ml Vial
BS4 69-0158			PM-KP	Remote Key Pad
BS4 69-0160			RK-2	Rack Mounting Kit with Handles, BS4 69-0152 Only
BS4 69-0165			HOLD1	Holder for Single-Barrel Pipette for BS4 69-0152 and BS4 69-0153
BS4 69-0166			HOLD4	Holder for 4-Barrel Pipette for BS4 69-0153 and BS4 69-0152

Below are the components supplied with each of the Pressure Injection Systems.

		BS4	BS4
Pressure Injection System		69-0152	69-0153
Cat. No.	**Product**	**Qty.**	**Qty.**
BS4 69-0154	IP1 Input Tubing with Connector	1	1
BS4 69-0156	OP2 Output Tubing with Connector Only	6	10
BS4 69-0157	FSW Foot Switch	1	1
BS4 69-0164	PP-4 Pulled 4-Barrel Pipette	1	-
BS4 69-0166	HOLD4 Holder for 4-Barrel Pipette	1	-
BS4 69-0163	PP-7 Pulled 7-Barrel Pipette	-	1
BS4 69-0167	HOLD7 Holder for 7-Barrel Pipette	-	1
-	Power Cord	1	1
-	User's Manual	1	1

Specifications

Output Channels	Four (PM-4) or eight (PM-8) injection / perfusion outputs, one synchronized drain out and one cell hold channel
Input Gas Pressure	30 to 100 p.s.i.
Clearing Pressure	Same as input pressure
Clear Hold Pressure	0 to 3 p.s.i. (regulated)
Injection Pressure	0.05 to 60 p.s.i. (regulated)
Balance Pressure	0.05 to 10 p.s.i. (regulated)
Fill Vacuum	0 to 24 in Hg (regulated)
Hold Vacuum	0 to 30 in of water (regulated)
Drain Vacuum	0 to 30 in of water (regulated)
Repeatability	±0.02 p.s.i.
Display Accuracy	±0.05 p.s.i. for pressure, ±0.2 in for vacuum (< 2 in H_2O)
Timer Setting Range	10 msec to 327.67 sec (10 msec resolution for whole range)
Counter Setting Range	1 to 255
Savable Sequences	16 sequences
Programmable Steps	32 steps for each sequence
Remote Control Ports	DB9 connector for remote key pad, foot switch jack and BNC for negative TTL trigger, jack connector for injection foot switch
Signal Output Ports	Eight BNCs for injection signal on output port 1 to 4
Power Consumption	100, 120 or 220 VAC, 35 W

BS4 69-0156 Output Tubing with Connector for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

BS4 69-0154 Input Tubing with Connector for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

BS4 69-0155 Output Tubing with Connector and 4.5 ml Vial for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

BS4 69-0157 Foot Switch Actuation for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

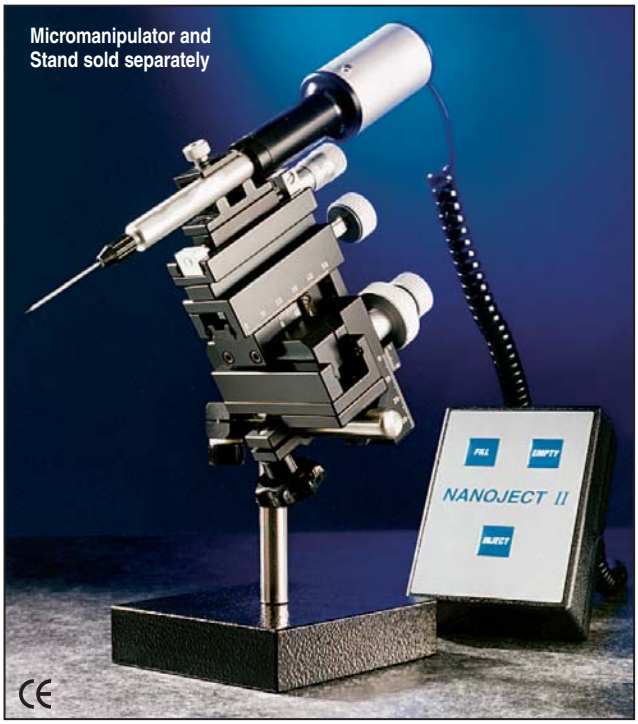
BS4 69-0164 and **BS4 69-0163** Pulled Pipettes for use with:
BS4 69-0152, see above
BS4 69-0153, see above

BS4 69-0158 Remote Key Pad to Control for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

BS4 69-0160 Rack Mounting Kit with Handles for use with:
BS4 69-0152, see above
BS4 69-0153, see above
BS4 69-0150, see page M52
BS4 69-0151, see page M52

Specialized Tools For Bioresearch

Nanoject II/Auto Nanoliter Injector



- Lower volume (2.3 nl) capability
- Positive displacement technology
- 2.3 to 69.0 nl range of volumes
- Minimal vibration
- New improved high torque motor
- Membrane key pad
- Improved micropipette holder
- Two speed injection/fill rates
- Auto 'Home' capability

The Nanoject II is the latest development in the Nanoject family of microinjectors. One of the unique features of the Nanoject II is the use of a higher torque motor than in previous models. This new motor is smoother in operation resulting in substantially reduced tip movement. A new collect configuration holds the micropipette more securely thereby reducing air infiltration and oil leakage. The two-speed fill/inject mode will allow the user to fill and inject at half speed, facilitating the use of smaller micropipettes. The handling of more viscous samples will also be improved. All of the above factors enhance the precise delivery of sample.

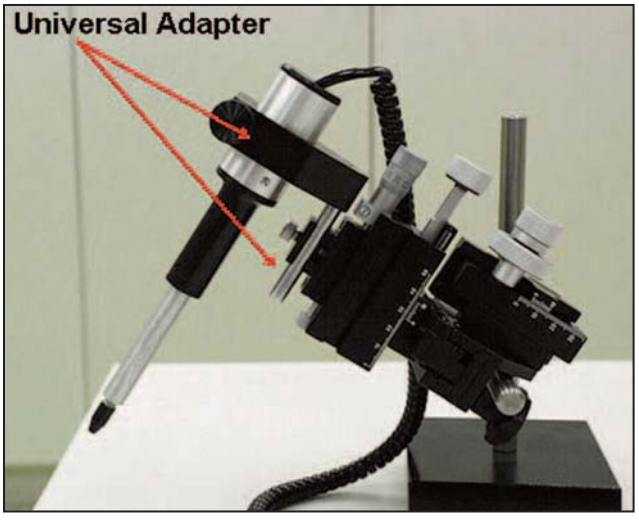
Volumes for the Nanoject II range from 2.3 nl to 69 nl. Although previous models of the Nanoject series are excellent for Xenopus injections, the smaller tips and smaller injection volumes of the Nanoject II allow users to perform injections into other specimens/applications that previously could not be performed.

Positive displacement technology and the use of precision micropipettes, eliminate the need for tedious calibration when the viscosity of the sample changes. Contaminants in the sample do not hinder or change the injection volume as with some other injectors. An optional universal mounting adapter provides easy mounting of the Nanoject II to a variety of micromanipulators and stereotaxic frames.

Specifications

Operation	Automatic
Glass Properties	Softening point 780°C
Glass Dimensions	1.14 x 0.053 mm (0.045 x 0.021 in) (OD x ID)
Injection Speed:	**Fast:** 46 nl/sec; **Slow:** 23 nl/sec
Fill Speed:	**Fast:** 46 nl/sec; **Slow:** 23 nl/sec
Empty Speed	92 nl/sec
Volume Range	2.3 nl to 69.0 nl
Change Volume	Dip switches #1 to #4
Change Inject Speed	Dip switch #5
Weight	99.2 g (3.5 oz)

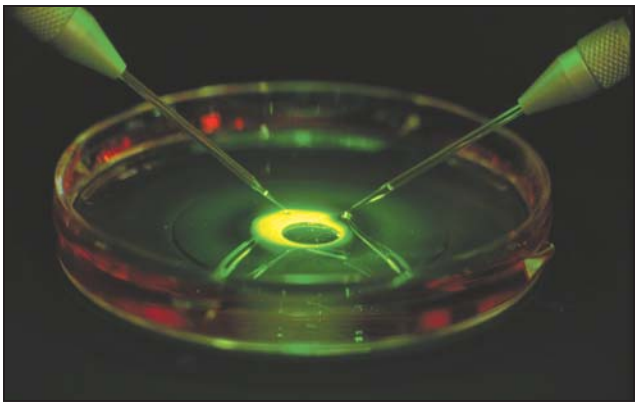
Catalog No.	$	Product
BS4 69-0130		Nanoject II Nanoliter Injector, 115 V, 60 Hz, US Plug
BS4 69-0131		Nanoject II Nanoliter Injector, 230 V, 50 Hz, European Plug
BS4 69-0132		Nanoject II Nanoliter Injector, 230 V, 50 Hz, UK Plug
Replacement Parts		
BS4 69-0133		Replacement Glass, 88.9 x 1.14 x 0.053 mm (3.5 x 0.045 x 0.021 in) (L x OD x ID), Vial of 100
BS4 69-0134		Replacement Glass, 177.8 x 1.14 x 0.053 mm (7 x 0.045 x 0.021 in) (L x OD x ID), Vial of 100
BS4 69-0135		Flared Glass, 90 mm (3.5 in), Vial of 100
BS4 69-0136		Standard O-Ring
BS4 69-0137		Special Flared O-Ring
BS4 69-0138		Replacement Wire Plunger
BS4 69-0139		Needle, 30 ga x 51 mm (2 in)
Accessories		
BS4 69-0140		Footswitch
BS4 69-0141		Support Base
BS4 69-0142		Universal Mounting Adapter, see below photo



For the PLI-90 and PLI-100 Pico-Injectors, see pages M71 to M73.

For HBIO/Warner's Oocyte Clamping Products, see pages H20 to H26.

NEW Micropipettes



- Ideal for cell research
- Compatible with all micromanipulator systems
- Available in five bend angles
- Gamma irradiated sterilization
- Disposable

These Micropipettes are ideal for stem cell research. The Chemical Drilling Micropipettes are specially designed for use with PiezoDrills. These disposable Micropipettes are individually sterilized and available in five bend angles. They are manufactured in an independently validated clean room to FED.STD.209E, class 10,000. All processes are controlled to BSEN46002 and ISO 9002, resulting in ultra-clean and uniform micropipettes.

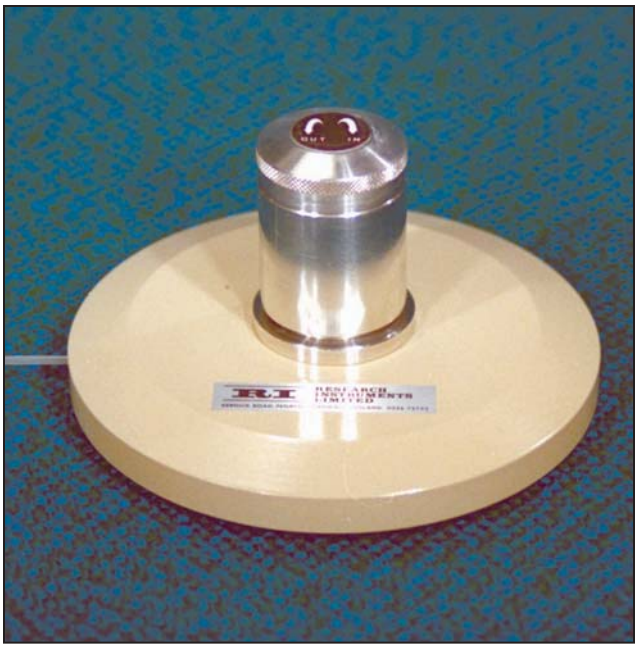
Each Micropipette is individually packed in a Twista-Pak™ that ensures easy, damage-free removal of the micropipette from its packaging. Five Twista-Paks are then sealed into a blister-pack to ensure that the micropipettes remain sterile and protected during freight.

Micropipettes, pkg. of 5

Bend Angle ID	Cell Holding Pipettes 15 µm	30 µm	Cell Removal Pipettes 20 µm	25 µm	30 µm	35 µm
0° $	BS4 72-6496	BS4 72-6506	BS4 72-7592	BS4 72-7597	BS4 72-7602	BS4 72-7607
20° $	BS4 72-6497	BS4 72-6507	BS4 72-7593	BS4 72-7598	BS4 72-7603	BS4 72-7608
25° $	BS4 72-6498	BS4 72-6508	BS4 72-7594	BS4 72-7599	BS4 72-7604	BS4 72-7609
30° $	BS4 72-6499	BS4 72-6509	BS4 72-7595	BS4 72-7600	BS4 72-7605	BS4 72-7610
35° $	BS4 72-6500	BS4 72-6510	BS4 72-7596	BS4 72-7601	BS4 72-7606	BS4 72-7611

Bend Angle ID	Cell Injection Pipettes 5 µm	8 µm	Stem Cell Injection Pipettes 14-17 µm	18-21 µm	22-25 µm	Chemical Drilling Pipettes 10 µm
0° $	BS4 72-7582	BS4 72-7587	BS4 72-6486	BS4 72-6511	BS4 72-6491	BS4 72-6501
20° $	BS4 72-7583	BS4 72-7588	BS4 72-6487	BS4 72-6512	BS4 72-6492	BS4 72-6502
25° $	BS4 72-7584	BS4 72-7589	BS4 72-6488	BS4 72-6513	BS4 72-6493	BS4 72-6503
30° $	BS4 72-7585	BS4 72-7590	BS4 72-6489	BS4 72-6514	BS4 72-6494	BS4 72-6504
35° $	BS4 72-7586	BS4 72-7591	BS4 72-6490	BS4 72-6515	BS4 72-6495	BS4 72-6505

Screw-Actuated Air Syringes



- For air-assisted micro-injection and micro-aspiration
- Uncomplicated and easy to use
- Accurate
- Sensitive control
- High suction/pressure

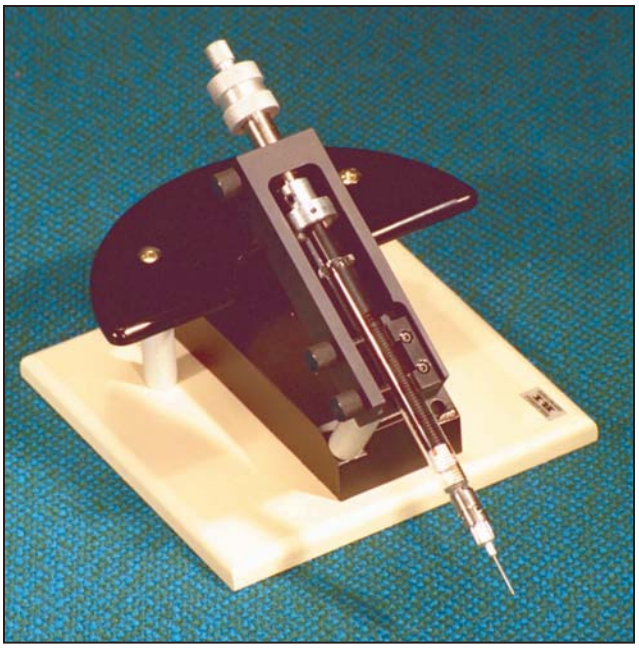
These air-assisted microinjection/micro-aspiration syringes provide the user with sensitive control and an extremely low dead-air volume. The capacity of the syringe is 10 ml. When required, the syringes can be used to generate high pressure or suction.

The screw-actuated syringe is a small compact unit incorporated into a heavy circular base. Its convenient dimensions enable it to be ergonomically positioned next to the control lever of a micromanipulator to facilitate single-handed operation of both instruments.

The syringe is connected by hard polyethylene tubing to a micropipette, which in turn, may be fitted to a micromanipulator or positioning device. Suction/injection is obtained by turning the metal colored actuator screw-control on the top of the syringe. The syringe provides a solution to the problem of capillary action when working with small micropipettes. A small balance (equilibrating) pressure can be maintained to offset the effects of capillary action. A conveniently situated release-button on-top of the screw-control is provided to achieve equilibration.

Catalog No.	$	Product
BS4 69-0105		Screw-Actuated Air Syringe

Screw-Actuated Micrometer Driven Hamilton Syringe



- Ideal for oil-filled injection/aspiration
- Easy to use
- Hamilton syringe incorporated
- Accurate
- Sensitive control
- Low dead-air volume
- High suction/pressure
- Easy to exchange or replace the syringe

This screw actuated syringe is a micrometer-actuated syringe mechanism mounted on a small base. This syringe is for oil/air-assisted micro-injections and micro-aspirations. Its compact dimensions enable it to be ergonomically positioned next to the control lever of a micromanipulator to facilitate single-handed operation of both instruments.

Suction/injection is achieved by using the rotary-actuator with a fine micrometer-thread, which has a 15 mm movement range. A Hamilton 1 ml Gastight glass syringe with a Luer-taper is incorporated. A Luer-taper hypodermic needle is mounted on the taper of the Hamilton syringe. The syringe is connected by hard polyethylene tubing to a micropipette, which in turn, may be fitted to a micromanipulator or similar instrument. The 1 ml Hamilton syringe can be easily exchanged for any other Hamilton 1700 syringe series including the 1000, 500, 200, 100 and 50 µl sizes, see Pumps Section A.

Catalog No.	$	Product
BS4 69-0107		Screw-Actuated Micrometer Driven Hamilton Syringe

Heating of Imaging and Recording Chambers: Application Fundamentals

Why Temperature Control?

Researchers have long understood the importance of temperature regulation in the study of cellular function. For example, a Medline search using the keywords "temperature" and "cell" produced over 18,000 references since 2003, most addressing the effect of temperature on the biophysical and metabolic function of cells. In addition, the performance of imaging system optics are exquisitely sensitive to temperature as revealed by a shifting focal plane as the temperature of the objective is varied. Therefore, for the scientist studying the function of cells in a recording environment, the importance of tight thermal control cannot be overstated. A number of issues confront the researcher attempting to maintain temperature control. These include maintaining a constant and uniform bath temperature under various flow rates and controlling for changes in the ambient temperature of the environment. In addition, effects due to the addition of cold drugs or solution to the perfusion path and heat sinks due to microscope optics and stage adapters must be addressed.

General Issues

Sources of Heat Flux

Heat flux pathways can be generally characterized as either conductive, convective, or radiative. Traditionally, the greatest effort is directed towards controlling conductive pathways, followed by convective pathways. We define a conduction heat pathway as one wherein heat energy is transmitted through a continuous intervening material. These include the microscope stage or objective, the perfusion solution, the chamber platform and other physical elements of the working environment. Heat flux through convective heat pathways are generally less significant but include evaporation or condensation and heat transfer due to the movement of air across the imaging chamber. Radiative pathways are, in comparison, easily controlled and will not be considered here.

Space and Time Considerations in Uneven Heat Conduction

We first consider sources of uneven heat distribution in the spatial regime. These include poor heat conduction across the chamber bath or from the platform to the chamber. Poor heat conduction across the bath is revealed as a temperature gradient from one location to another within the bathing solution. A gradient of this type is usually induced by an immersion objective placed directly under the sample. Heat flux through this pathway can be significant, resulting in as much as a 10°C temperature change within 3-5 mm. Another, less dramatic, temperature gradient can be generated in the bath by restricting the application of heat to just the chamber platform. Since the platform applies heat only along the edge of a chamber, a temperature gradient will be established due to the heat capacity of water coupled with flow of relatively cold solution into the chamber.

Uneven heating in the temporal regime can be generated by varying the rate cool perfusion solution is introduced into a heated platform, or by introducing drugs or solution into the perfusion path at a temperature different than that currently being perfused. These considerations will be addressed in greater detail below.

Outgassing

Another significant issue related to the application of heat to perfusion solutions is termed outgassing. Under standard conditions, atmospheric gas in contact with a liquid solubilizes into solution and tends towards an equilibrium determined in part by the gas' partial pressure and the temperature of the liquid. Generally speaking, cold liquids are capable of solubilizing a greater volume of gas than a warm liquid. Thus, as the temperature of the liquid increases, dissolved gasses come out of solution resulting in the appearance of bubbles.

Heating Methods

A number of approaches are used by investigators to regulate the temperature of a sample under study. These include warming the chamber platform and/or microscope optics using resistive, Peltier, or liquid based application devices, channeling warm air across the imaging chamber and/or optical components, and regulating the temperature of the perfusing solution. Techniques for regulating the temperature of perfusing solutions include preheating the solution reservoir and/or using inline solution heaters in the perfusion pathway. Each strategy has its strengths and weaknesses and are discussed below.

How Temperature is Sensed

In general, temperature is measured using a thermistor or similar device and fed back into a temperature controller which adjusts power to the heating element. When regulating temperature it is important to account for the response time of the feedback loop since this can cause the system to oscillate.

Control and Regulation

Warner Instruments temperature controllers utilize two thermistors per channel to provide monitoring and feedback information to the controller. One thermistor is placed within the heated element (e.g., chamber platform, in-line heater, etc.) to measure the temperature of the heater block. Information from this thermistor is fed back to the control mechanism which applies sufficient power to the heater to maintain the controller set point.

The second thermistor is usually placed in the solution path close to the sample under study and measures the temperature at the sample. Information from this thermistor is used by the researcher to readjust the set point of the controller and to monitor the performance of the system.

This approach is very effective in providing tight thermal control (± 0.1°C) of the heating element, and consequently the perfusion solution, as long as the feedback loop is sufficiently optimized. Warner Instrument temperature controllers are provided with user selectable feedback response time constants allowing the instrument to accommodate different operating conditions

Methodology

In-Line Solution Heating

The simplest and most direct approach for the application of heat to a sample is to preheat the perfusion solution immediately prior to its delivery to the chamber. The warmed perfusate washes over the sample and maintains a uniform temperature at the sample, even with variable flow rates. This method works well as long as solution continues to flow through the heater into the chamber.

A number of considerations are important when using this approach. First, it is important to minimize the distance between the heater and chamber. If too much heat is lost en route, the user can attempt to raise the heater controller set point above the boiling point of the solution. In addition, care must be taken to maintain flow rates such that the solution temperature reaches equilibrium prior to leaving the heater.

Chamber Platform Heating

Another strategy is to heat the chamber platform. This is usually achieved by using a resistive element and this approach is provided for in Warner chambers. A slightly more sophisticated tactic would be to supply heat to the platform using either a Peltier or liquid based heating element. Regardless of the method employed, this strategy is best suited for conditions where the solution flow rate is extremely slow or nonexistent.

A number of considerations are important when using this approach. First, the perfusing solution receives heat energy only after entering the chamber, thus generating a temperature gradient within the bath. Second, since heat energy is only applied to the edges of the chamber by the platform, the rate of heat transfer to the solution is very slow. However, this approach excels for conditions where solution flow is nonexistent, such as maintaining a constant temperature while loading cells with indicator dyes.

Solution Reservoir Heating

Heating the solution reservoir is not generally considered a successful strategy for maintaining temperature in the bath since most, if not all, of the heat energy is lost en route to the chamber. However, this technique is important if outgassing of solutions is a problem. Since the gas load of a solution is dependent on partial pressure and temperature, preheating the solution at atmospheric pressure before delivery to the final heater will minimize the occurrence of bubbles in the bath, even if the solution is allowed to cool en route. Therefore, solution reservoir heating is best used in combination with other heating techniques as described below.

Microscope Objective Heating

While necessary, the use of immersion objectives in imaging presents a difficult problem for the researcher attempting to maintain temperature at the sample. Since the objective is in direct contact with the solution or chamber and is placed immediately above or below the sample, it presents a significant conduction pathway within the system.

Heated objective collars are commercially available and are designed to minimize heat flux through the optics. However, many researchers indicate that small variations in temperature as the collar cycles off and on induces an oscillating shift in the focus plane. In addition, many researchers express concerns about the effects of deep cycling an objective between significantly different temperatures between uses. Some investigators address this issue by maintaining the objective at a constant temperature, even when not in use.

Heated Enclosures

Another strategy currently in use is to encase the imaging chamber and microscope optics within a heated enclosure. The main advantage of this approach is that both the chamber and objective are maintained at a stable and uniform temperature. Heat is usually applied to the environment by the introduction of warmed air to the enclosure. Some disadvantages are slow responses to changes in the thermal set point, possible introduction of airborne contaminates from the blower system, and the requirement for bulky equipment on or about the imaging system.

Discussion

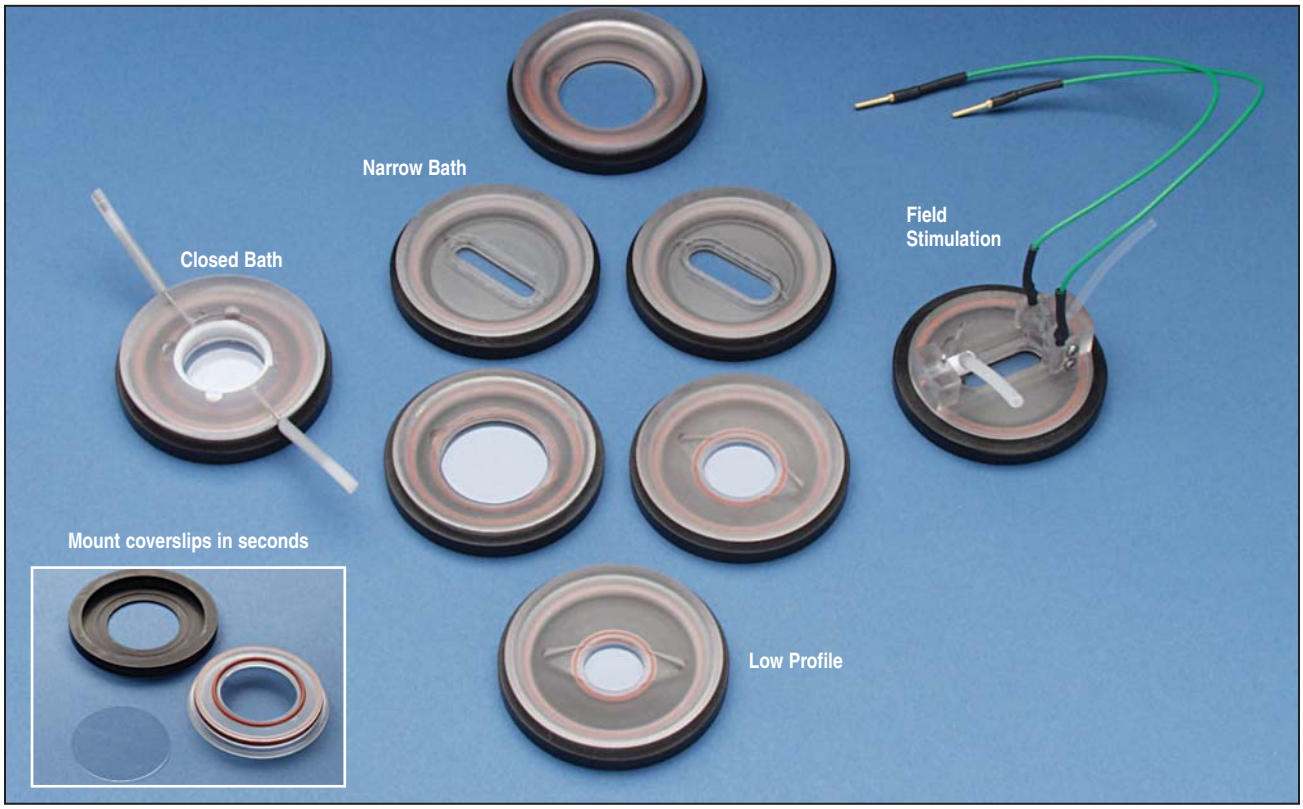
Each heating strategy discussed above has strengths and weaknesses making it an incomplete solution for issues encountered with heating. However, most experimental difficulties can be solved by using these strategies in combination.

For example, platform heating alone is not sufficient to stably heat a perfusing solution, but is necessary if solution flow is to be interrupted for any reason. In addition, the most effective method of heating a perfusion solution is via an in-line heater. Therefore, an optimal combination for experiments where tight thermal control is desired under variable, very slow, or interrupted flow conditions would be a combination of in-line and platform heating.

If solutions are stored cold and used before reaching operating temperature, or if the temperature is changed during an experiment, then outgassing at the sample can be a significant problem. This is addressed by including reservoir preheating in the experimental setup. However, reservoir heating is unable to supply heated solutions to the chamber and is best used in combination with an in-line solution heater.

Of course, all three approaches can be used in combination to provide efficient thermal regulation under virtually any condition. Warner Instrument Corporation provides high quality single and dual channel temperature controllers, as well as solution reservoir, chamber platform, and in-line solution heaters. We invite you to call our technical support staff and we will be glad to aid you in determining the best application of these heating strategies to your experimental setup.

The Series 40 Family of Imaging Chambers



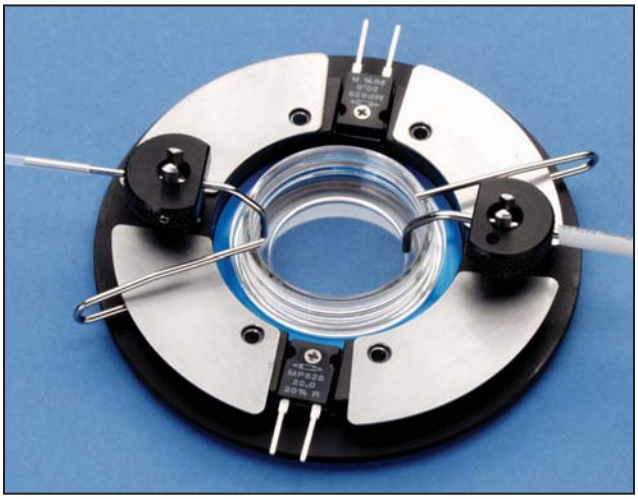
RC-40 Quick Change Imaging Chambers

- O-ring seals permit quick exchange of coverslips
- Anodized aluminum base ensures good heat transfer
- Open and closed bath designs
- Use standard # 1 or #1.5 thickness coverslips
- Ideal for rapid screening assays

Warner Instruments is pleased to introduce a new family of chambers designed to meet the need for rapid screening of cells grown on coverslips. The innovative design uses O-rings to seal the coverslip to the polycarbonate chamber. Therefore little or no silicone grease is needed and mechanical fasteners are not required for coverslip mounting.

Chambers are available for use with 15, 18, and 25 mm round coverslips. Round, low profile chambers maximize the viewing area and provide optimal access for electrodes. Slotted bath chambers allow rapid solution exchange. A version which includes platinum wires may be used to study cardiac myocytes and other applications requiring field stimulation. The RC-40HP High Profile Chamber allows for a deep bath.

The Series 40 chambers are designed to be compatible with the Warner QE-1 Quick Exchange Platform and the DH-35i Culture Dish Incubator.

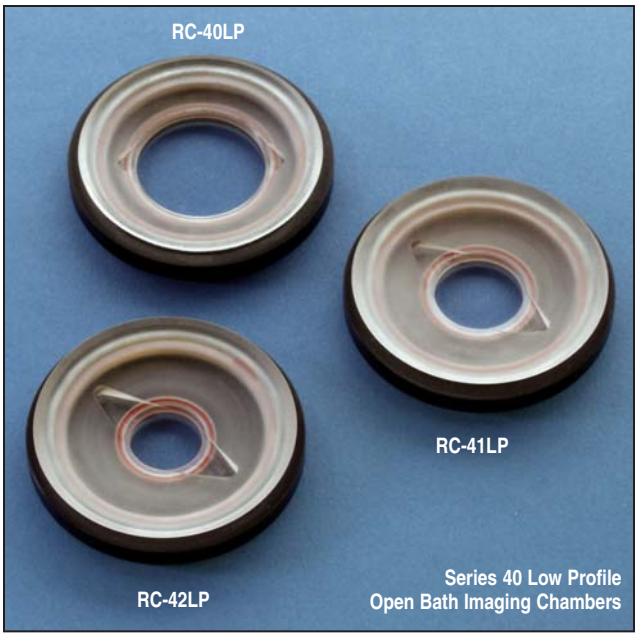


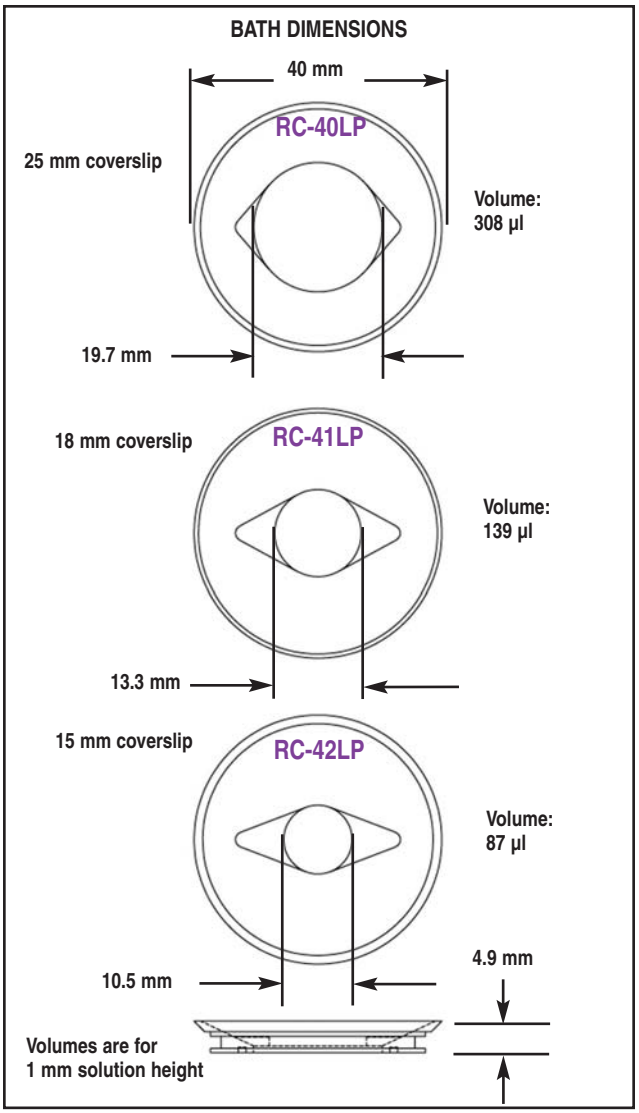
The QE-1 Quick Exchange Platform

The Warner QE-1 Quick Exchange Platform is a versatile base for the RC-40 Series chambers, as well as many popular 35 mm glass bottom dishes. Removable perfusion and suction tubes allow solution exchange in any of the RC-40 Series open bath chambers or 35 mm dishes. The platform may be heated using any of the Warner temperature controllers.

The QE-1 can be mounted on most microscopes by using the Warner Series 20 stage adapters. See page M86 for more information on the QE-1.

Series 40 Low Profile Chambers for 15, 18 and 25 mm Coverslips





- Low profile design permits low entry angle of electrodes
- Excellent optical and mechanical access to cells and tissue
- When used with QE-1 Quick Exchange Platform, both temperature and perfusion control are possible

The Series 40 family of chambers was designed for research requiring fast exchange of coverslips. The chamber design consists of two parts: a polycarbonate chamber and a 40 mm diameter aluminum base. O-rings are used to seal the coverslip to the polycarbonate chamber and to hold the chamber securely in the aluminum base.

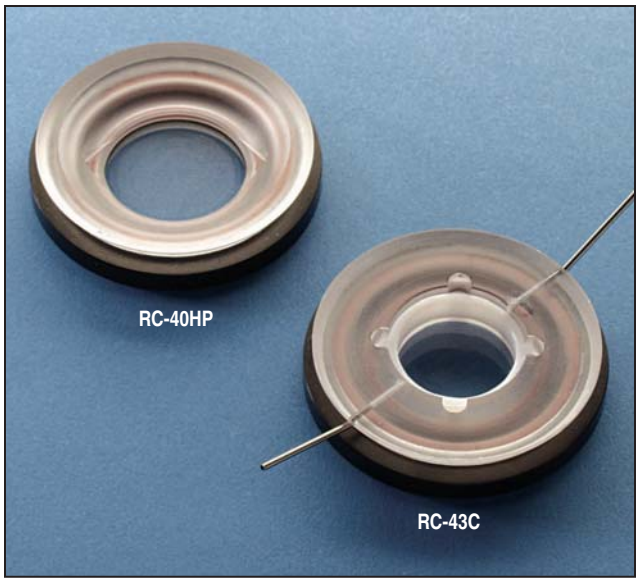
Open bath models are designed for electrophysiological recording and/or optical imaging, and are used in applications including patch clamp, oocyte clamp, and physiological measurements on cell cultures and tissue preparations. The low profile design permits good electrode access to the bath.

The RC-40LP, 41LP, and 42LP Chambers use 25, 18, and 15 mm round coverslips, respectively, in a round bath design to provide maximum viewing area. The chambers work equally well with both water and oil immersion objectives.

The RC-40LP, 41LP, and 42LP Chambers are supplied with one package of #1.5 coverslips each (25, 18, and 15 mm round, respectively) and spare O-rings.

Catalog No.	$	Model	Product
BS4 64-0367		RC-40LP	Quick Change Chamber 25 mm Low Profile
BS4 64-0368		RC-41LP	Quick Change Chamber 18 mm Low Profile
BS4 64-0369		RC-42LP	Quick Change Chamber 15 mm Low Profile
Accessories/Replacement Parts			
BS4 64-0375		QE-1	Quick Exchange Heated Base for RC-40 Series
BS4 64-0703		CS15R	Coverslips 15 mm Dia. #1 – Box /100
BS4 64-0384		CS18R	Coverslips 18 mm Dia. #1 – Box /100
BS4 64-0705		CS25R	Coverslips 25 mm Dia. #1 – Box /100
BS4 64-0713		CS15R15	Coverslips 15 mm Dia. #1.5 – Box /100
BS4 64-0714		CS18R15	Coverslips 18 mm Dia. #1.5 – Box /100
BS4 64-0715		CS25R15	Coverslips 25 mm Dia. #1.5 – Box /100

RC-40 Series Closed Bath and High Profile Chambers for 25 mm Coverslips



- O-ring seals permit quick exchange of coverslips
- Anodized aluminum base ensures good heat transfer
- Open and closed bath designs
- Use standard #1 or #1.5 thickness coverslips
- Ideal for rapid screening assays

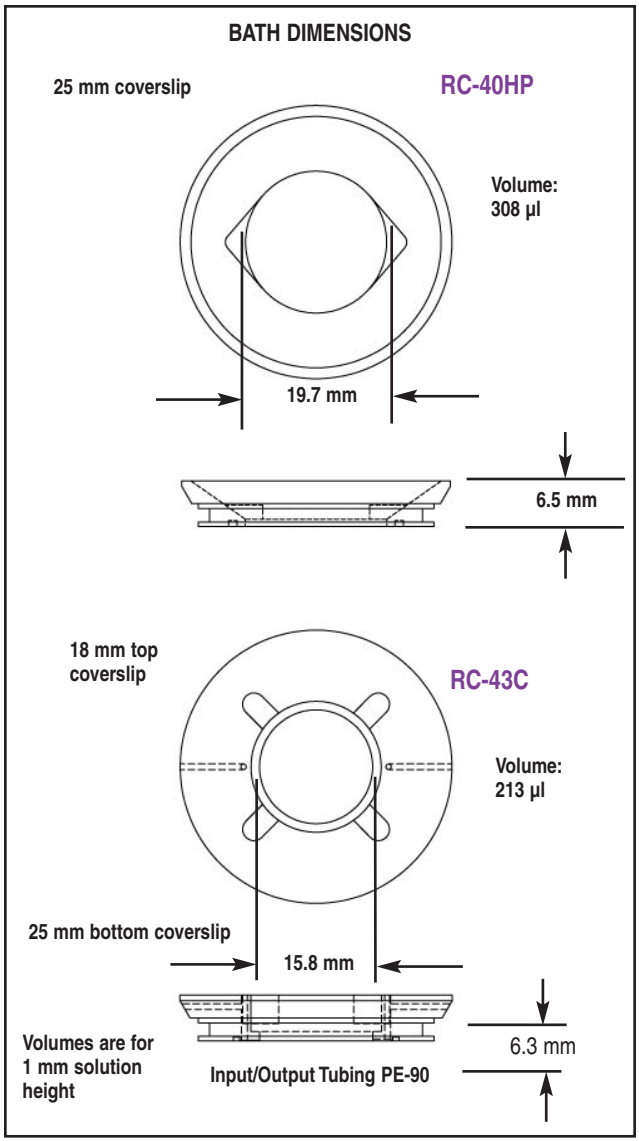
The RC-40HP uses 25 mm coverslips to form the chamber bottom. Tapered 6.5 mm interior sides provide clearance for pipettes, injectors, etc. and allow for a greater bath depth than the 40LP Series.

The RC-40HP Chamber is supplied with one package of #1.5 coverslips, 25 mm diameter.

The RC-43C is the closed bath member of the Series 40 family. The closed bath promotes an even and continuous solution exchange and eliminates changes in focus due to alterations in bath height. Studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface.

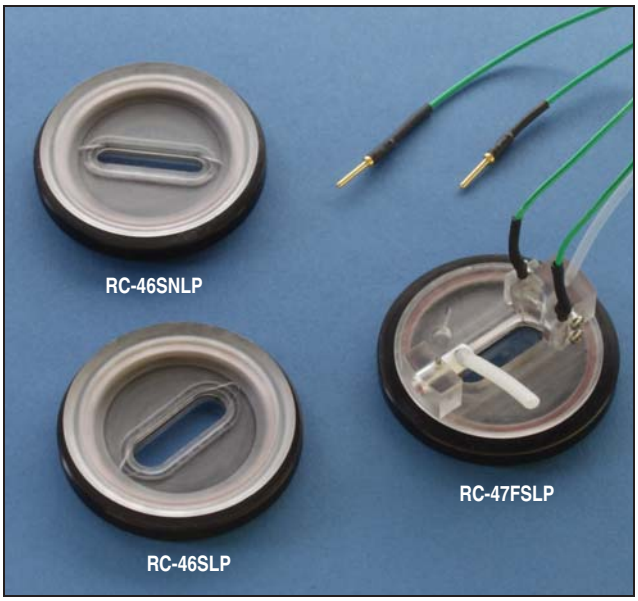
Fluid is delivered to a 20 gauge stainless steel perfusion inlet port and removed from the chamber by means of a similar outlet port. The top coverslip is held in place with a retainer; a thin coating of silicone grease forms the seal. The distance between top and bottom coverslips is 1 mm.

The RC-43C Chamber is supplied with one package each of #1.5 coverslips (25 and 18 mm round, respectively) and spare O-rings. Additionally, the RC-43C is supplied with 10 feet of PE-160 and PE-90 Polyethylene Tubing.



Catalog No.	$	Model	Product
BS4 64-0370		RC-40HP	Quick Change Chamber High Profile
BS4 64-0371		RC-43C	Quick Change Chamber Closed Bath
Accessories/Replacement Parts			
BS4 64-0375		QE-1	Quick Exchange Heated Base for RC-40 Series
BS4 64-0384		CS18R	Coverslips 18 mm Dia. #1 – Box /100
BS4 64-0705		CS25R	Coverslips 25 mm Dia. #1 – Box /100
BS4 64-0714		CS18R15	Coverslips 18 mm Dia. #1.5 – Box /100
BS4 64-0715		CS25R15	Coverslips 25 mm Dia. #1.5 – Box /100

Series 40 Slotted Bath Low Profile Chambers for 25 mm Coverslips



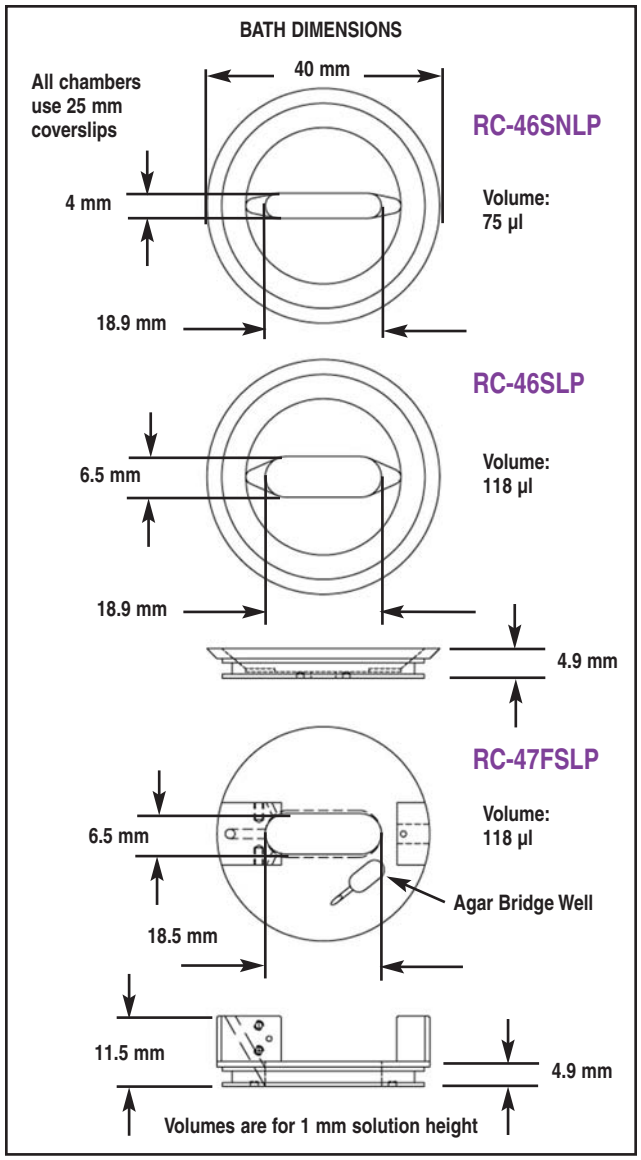
- Low profile design permits low entry angle of electrodes
- Slot-shaped bath for applications requiring rapid perfusion
- Platinum electrodes for applications requiring field stimulation
- When used with QE-1 Quick Exchange Platform, both temperature control and perfusion are possible

The RC-46SLP, RC-46SNLP, and RC-47FSLP Chambers use a 25 mm round coverslip in a slotted bath design to provide rapid perfusion exchange. O-rings seal the coverslip to the polycarbonate chamber and hold the chamber securely in the aluminum base.

The low volume of these slotted bath chambers and the natural laminar flow allows rapid exchange of solution, facilitating drug application studies.

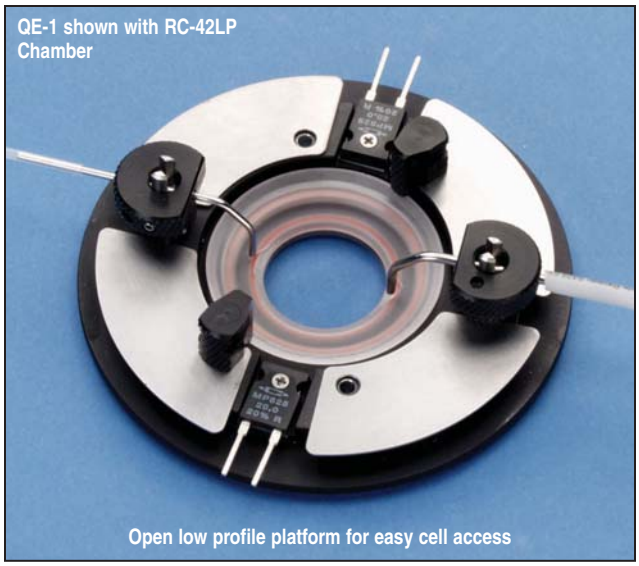
The RC-47FSLP includes a pair of platinum wires placed onto the parallel sides of the oval shaped bath. The connecting wires are terminated in 1 mm pins. This model includes a perfusion inlet port and a 16 gauge adjustable suction tube. An agar bridge well has been added to accommodate a bath ground electrode.

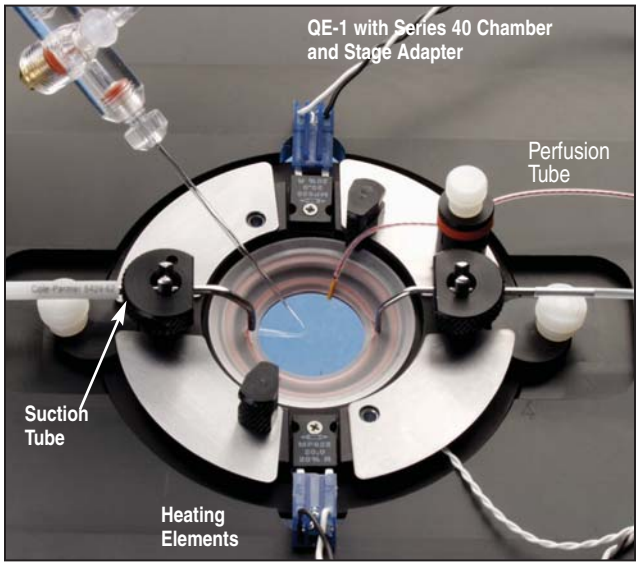
All chambers mount in the QE-1 Quick Exchange Platform. Chambers are supplied with one box of #1.5 thickness, 25 mm coverslips and spare O-rings. Additionally, RC-47FSLP is supplied with 10 feet of PE-160 Polyethylene Tubing.



Catalog No.	$	Model	Product
BS4 64-0372		RC-46SLP	Quick Change Chamber Slotted Bath
BS4 64-0373		RC-46SNLP	Quick Change Chamber Narrow Slotted Bath
BS4 64-0374		RC-47FSLP	Quick Change Chamber w/ Field Stimulation
Accessories/Replacement Parts			
BS4 64-0375		QE-1	Quick Exchange Heated Base for RC-40 Series
BS4 64-0705		CS25R	Coverslips 25 mm Dia.#1 Box/100
BS4 64-0715		CS25R15	Coverslips 25 mm Dia.#1.5 Box/100
BS4 64-1424		SIU-102	Stimulus Isolation Unit
BS4 64-1425		CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)

Model QE-1 Quick Exchange Heated Platform with Perfusion





Quick Exchange Platform

- Open design for easy cell access
- Removable perfusion and suction tube holders
- Quick exchange of chamber or 35 mm dish
- Designed for 35 mm dishes and Series 40 chambers
- Magnetic stainless steel allows for the use of magnetic holders

The Warner QE-1 Quick Exchange Platform is a versatile base for the RC-40 Series chambers, as well as many popular 35 mm glass bottom dishes. The platform is at home on both upright and inverted microscopes and includes resistive heating elements. The base has a 25 mm diameter aperture. Magnetic stainless steel along the perimeter of the QE-1 permits the use of Warner's MC-1 Magnetic Clamp Kit, which includes a variety of holding tools.

Removable perfusion and suction tubes allow perfusion in any of the RC-40 Imaging Chambers or 35 mm dishes. Suction and perfusion tubes also feature set-screw locks for the horizontal location, and adjustable presets on the vertical for setting the bath height. These adjustments permit easy and exact positioning and repositioning of the suction and perfusion tubes. A redesigned suction tube eliminates tidal action and fluid flutter, making aspiration very quiet.

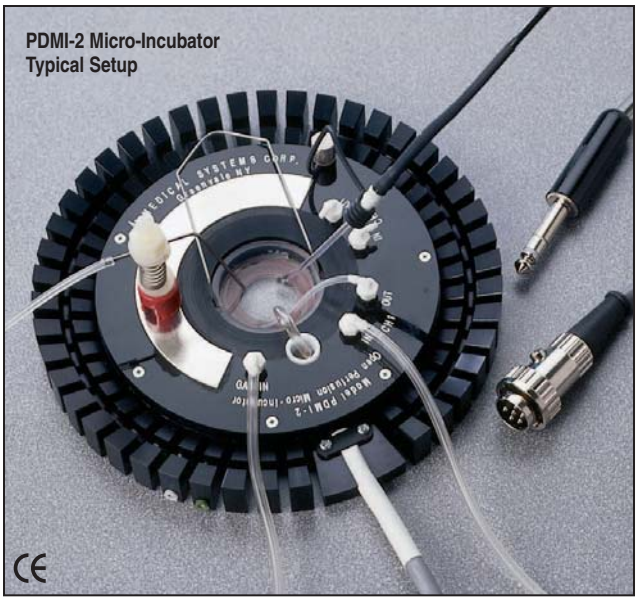
Resistive heating of the QE-1 is provided by means of our TC-324B/TC-344B Temperature Controllers and a CC-28 Cable. Heating of perfusate is achieved using our SH-27B or SF-28 In-Line Solution Heaters.

Adapter rings for Corning, Falcon and Willco 35 mm dishes are supplied to ensure a close fit in the QE-1.

Stage adapters are available for all major microscopes. Custom or modified stage adapters are also available; call our Technical Support Department for details.

Catalog No.	$	Model	Product
BS4 64-0375		QE-1	Quick Exchange Heated Base w/Perfusion and Adapter Ring Kit
Accessories/Replacement Parts			
BS4 64-0351		AR-4	Replacement Adapter Ring Kit for 35 mm Dishes
BS4 64-0100		TC-324B	Single Channel Heater Controller
BS4 64-0101		TC-344B	Dual Channel Heater Controller
BS4 64-0106		CC-28	Cable Assembly for Heater Platforms
BS4 64-0102		SH-27B	Solution Heater
BS4 64-0357		MCK-1	Magnetic Clamp Kit

PDMI-2 Open Perfusion Micro-Incubator


PDMI-2 Micro-Incubator
Typical Setup

PDMI-2 with TC-202A
Temperature Controller
(Not Included)

- Heats and cools
- ~5° to 50°C
- Maintains required cell environment for hours:
  - pH and O_2
  - temperature
- Peltier heat pump
- Flexible chamber option
- Easily change perfusion fluid
- Makes temperature cycle experiments easy

The PDMI-2 operates equally well under static or perfused conditions. When operated with perfusion, the micro-incubator's unique design places flexible tubes carrying inflowing perfusate in contact with a temperature regulated Peltier heat pump driven plate, thus heating or cooling the incoming fluid to a command temperature. This eliminates the need for auxiliary preheating or cooling. The Peltier plate heats or cools the cell carrying central chamber uniformly when no perfusate is flowing.

Flexible Temperature Range

The operating temperature range of the PDMI-2 Open Perfusion Micro-Incubator is nominally ~5° to 50°C when used with the TC-202A Temperature Controller, see page M125. Lower temperatures can be achieved (approximately 10° below ambient) by using an optional cool tube water-carrying coil which attaches to the perimeter of the PDMI-2. Temperatures stabilize quickly throughout the operating range; temperature uniformity across the chamber is excellent.

Optimal and Flexible Perfusion

Two temperature controlled perfusion lines deliver perfusates through the micro-incubator into the chamber a nominal rate of 3 ml per minute each. Fluid level is maintained by placing an aspirator (model LU-ASP) in the chamber. Fluid height is easily adjusted via a simple screw mechanism; a cleverly designed suction port eliminates fluid flutter thus making aspiration quiet; a magnetic base secures the aspirator to the micro-incubator at a user selectable convenient location.

Excellent pH Control

The PDMI-2 also provides gas flow over the top of the chamber for pH control and improved temperature uniformity. The open design provides excellent mechanical and optical access to the media.

Low Noise Conditions

A teflon well is provided with an Ag/AgCl electrode at its base to allow for the formation of a salt bridge when making low noise electrophysiological recordings.

Specifications

Chamber Options	Corning 35 mm Petri dishes, LU-CSD, MSC-TD or MSC-PTD
Recommended Gas Flow	0.5 to 2.0 L/min
Temperature Range	~5° to 10°C below ambient to 50°C without water cooling
Temperature Stability	±0.2°C with TC-202A, at 37°C with 1 ml/min perfusion
Temperature Gradient Across Chamber	2°C with 1.5 ml media volume, 1 ml/min perfusion
Built-In Temperature Sensor	Thermistor, 100 k Ω at 25°C - YSI 44011
Peltier Device Current Rating	6 A max.
Media Perfusion Rates	Up to 3.0 ml/min
Overall Dimensions, H x D	17 x 152 mm (0.67 x 6.0 in)
Weight	0.5 kg (17.9 oz)
Microscope Stage Mounting	Call Harvard Apparatus for options

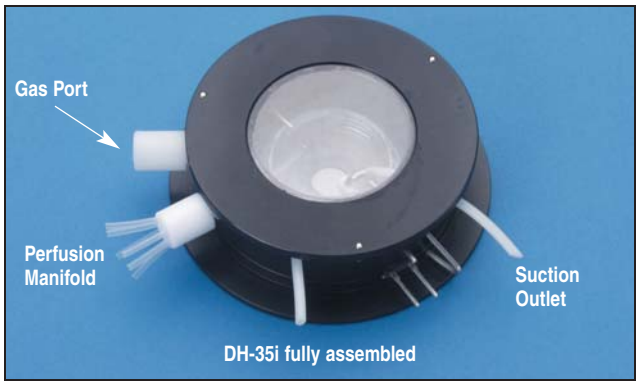
Catalog No.	$	Product
BS4 65-0043		PDMI-2 Open Perfusion Micro-Incubator, comes with LU-PD and LU-ASP (Adapter not included, see page M93)
BS4 65-0058		Copper Cooling Tube for PDMI-2

For TC-202A Bipolar Temperature Controller, see page M125

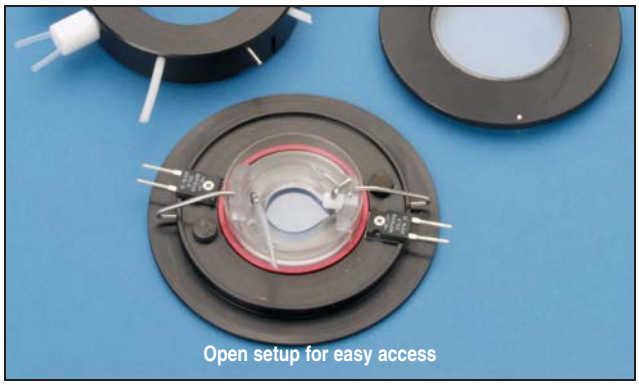
For CO_2/pH Controller, see page M144

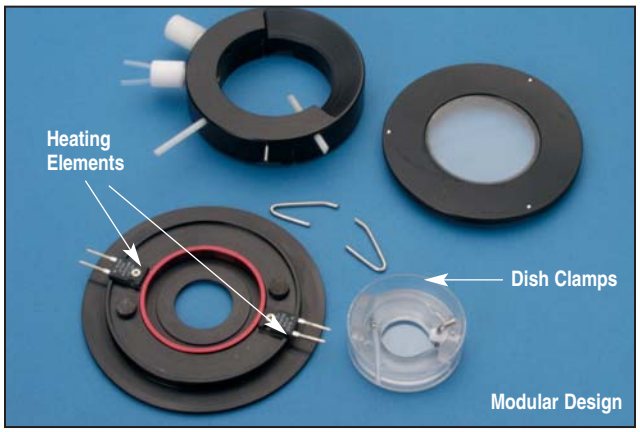
Chambers for 35mm Cell Culture Dishes

NEW DH-35i Micro-Incubation System for 35 mm Cell Culture Dishes



DH-35i fully assembled


Open setup for easy access



Modular Design

Adapter rings for Corning, Falcon, and Willco 35 mm dishes

- Designed for glass bottom 35 mm dishes
- Permits imaging, temperature and gas environment control
- Compatible with Corning and Falcon dishes and Willco Wells.
- Unique dish clamps allow easy cell access
- Compatible with RC-37 cell culture dish perfusion chamber insert.

The introduction of glass bottomed 35 mm culture dishes extended their use into areas such as confocal microscopy, fluorescence microscopy, and high resolution image analysis. The DH-35i Culture Dish Incubator is a system designed for imaging live cells in an open culture dish for easy access or in a closed dish for gas atmosphere control.

DH-35i Incubators work well with Willco Wells, Corning and Falcon glass bottom 35 mm culture dishes. Adapter rings are supplied to ensure a close fit for the supported dish. Dishes can be placed in the holder with or without dish covers.

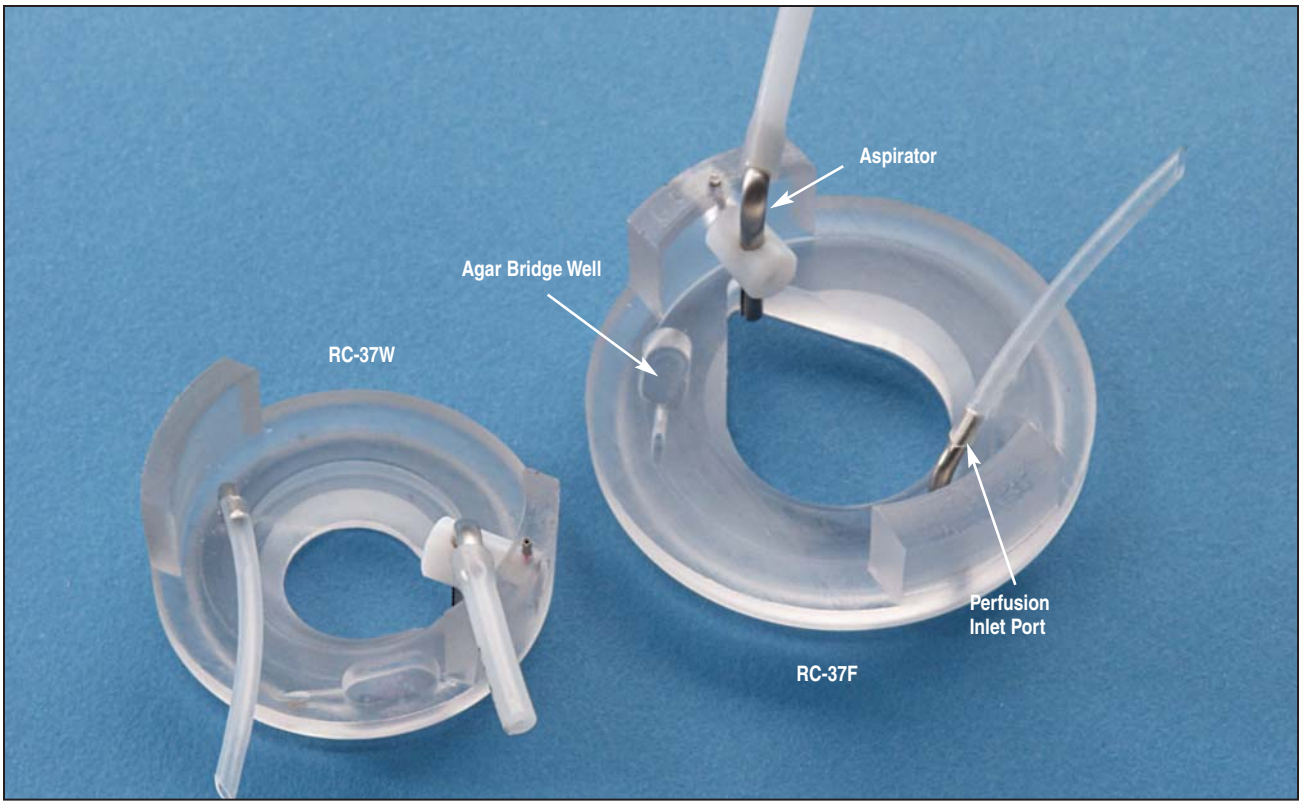
The holder is machined in three pieces. The midsection and top are easily removed for dish replacement and enables the positioning of electrodes at low angles. Resistive heating of the DH-35i is provided via the optional Warner TC-324B Temperature Controller and a CC-28 cable. Clamps are provided to ensure good contact between the dish and the heated surface and to prevent unwanted movement. The removable midsection is magnetically secured and has several ports to allow multi-channel perfusion, atmospheric maintenance, and aspiration of the dish. The base of the holder has a 19 mm aperture and the removable cover features a 36 mm glass aperture.

When combined with the Warner RC-37 Cell Culture Perfusion Chamber Insert, a complete micro-environmental system is achieved. This system is compatible with Warner's SH-27B and SF-28 In-line Solution Heaters. Included with the system are an MP-2 Perfusion Manifold and a set of 4 culture dish adapter rings.

Stage adapters are available for all major microscopes. Custom or modified stage adapters are also available; call our technical support department for details. See page M114 for Series 20 Stage Adapters.

Catalog No.	$	Model	Product
BS4 64-0349		DH-35i	Culture Dish Incubation System DH-35i
Accessories/Replacement Parts			
BS4 64-0351		AR-4	Replacement Adapter Ring Kit for DH-35i set of 4
BS4 64-0100		TC-324B	Heater Controller, Single Channel
BS4 64-0101		TC-344B	Heater Controller, Dual Channel
BS4 64-0106		CC-28	Cable Assembly for Heater Platforms
BS4 64-0102		SH-27B	Solution Heater

RC-37 Cell Culture Dish Perfusion Chamber Insert



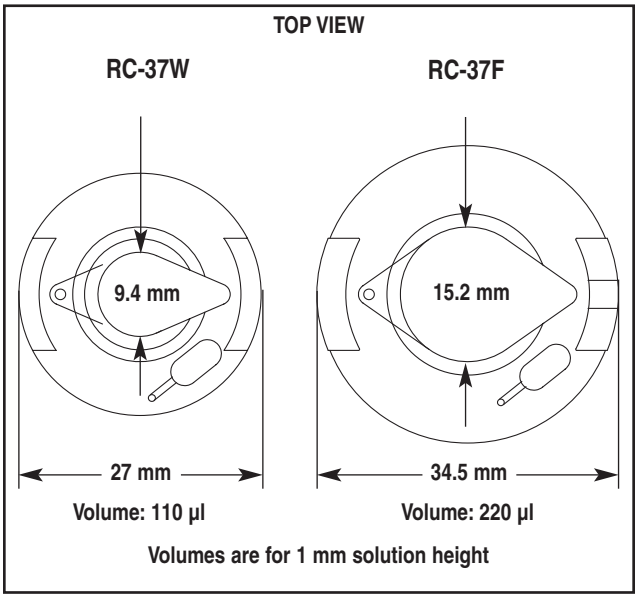
- Designed for glass bottom 35 mm culture dishes
- Permits imaging, recording and perfusion in the culture dish
- Open and closed bath designs
- Incorporates Warner's diamond fluidics
- Ideal for rapid screening assays

Culture Dish Perfusion

The introduction of thin glass bottom culture dishes has expanded the use of these popular tools dramatically. Applications such as live cell imaging, confocal microscopy and time-lapsed photography are now possible. The ability to exchange the extra-cellular environment by perfusion within 35 mm dishes has been difficult at best, until now.

The RC-37 Perfusion Chamber Insert for cell culture dishes makes perfusion within these dishes a simple matter. Fluid is delivered to a perfusion inlet port and removed from the chamber by means of a height adjustable aspirator.

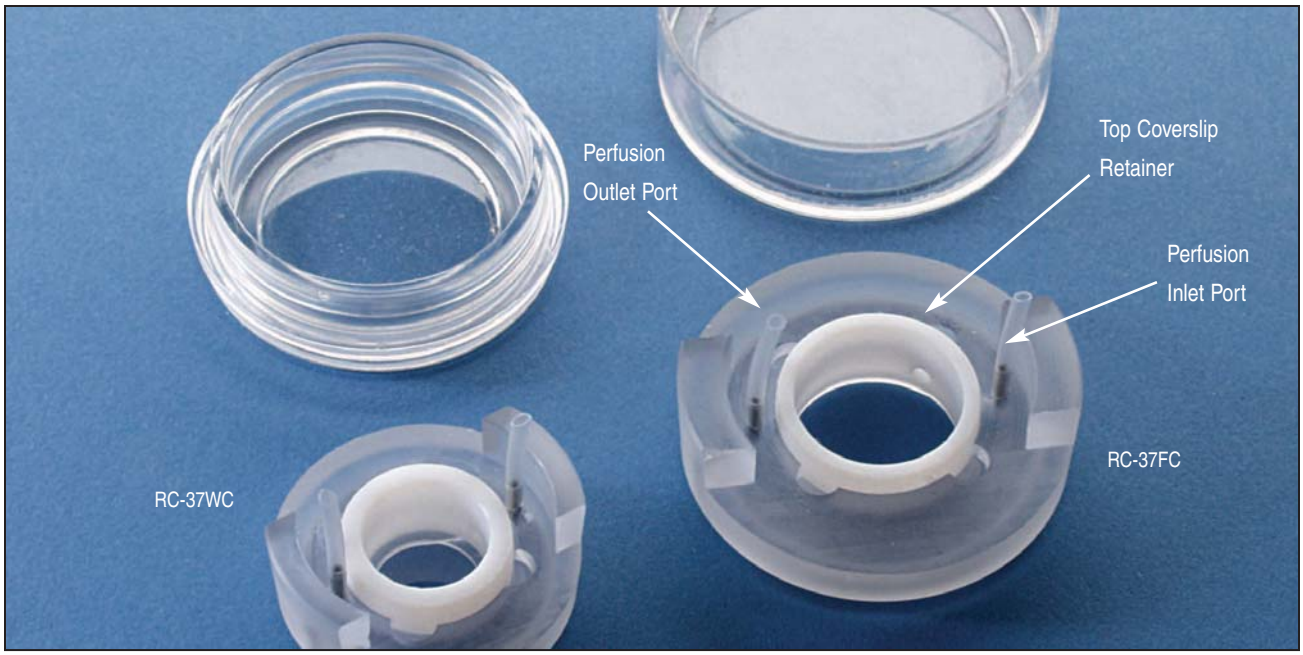
Chambers are available to fit the Willco Wells, and the Corning or Falcon 35 mm dishes. The chamber is compatible with Warner's DH-35 Culture Dish Heater and the DH-35i Culture Dish Incubator.



Catalog No.	$	Model	Product
BS4 64-0347		RC-37W	Chamber Insert for Willco/Corning 35 mm Dishes
BS4 64-0348		RC-37F	Chamber Insert for Falcon/Corning 35 mm Dishes

Chambers for 35mm Cell Culture Dishes

NEW Models RC-37WC and RC-37FC – Closed Bath Chambers



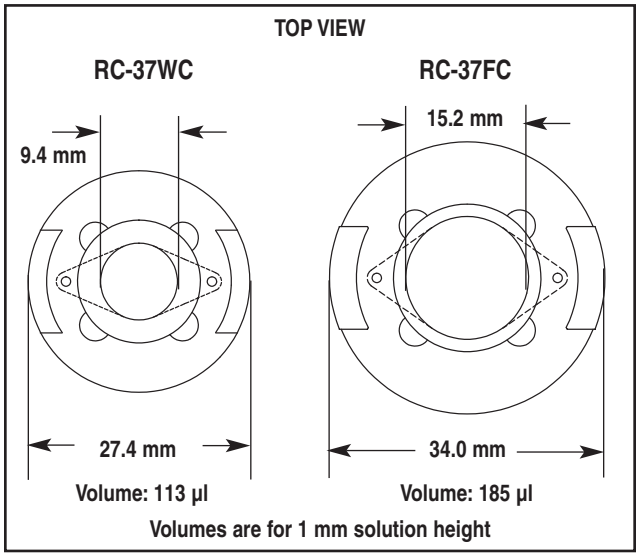
- Designed for glass bottom 35 mm dishes
- Permits imaging and perfusion in the cell culture dish
- Incorporates Warner's diamond fluidics
- Ideal for rapid screening assays

The RC-37 family of perfusion chamber inserts makes perfusion of cell culture dishes a simple matter. The closed bath promotes an even and continuous solution exchange and eliminates changes in focus due to alterations in bath height. Studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface.

Fluid is delivered to a 18 gauge perfusion inlet port and removed from the chamber by means of an outlet port of the same gauge. The top coverslip is held in place with a retainer and the dish becomes the chamber bottom. A thin coating of silicone grease forms the seal. The distance between top and bottom coverslips is 1 mm. The RC-37WC uses 15 mm top coverslips and the RC-37FC works with 18 mm coverslips.

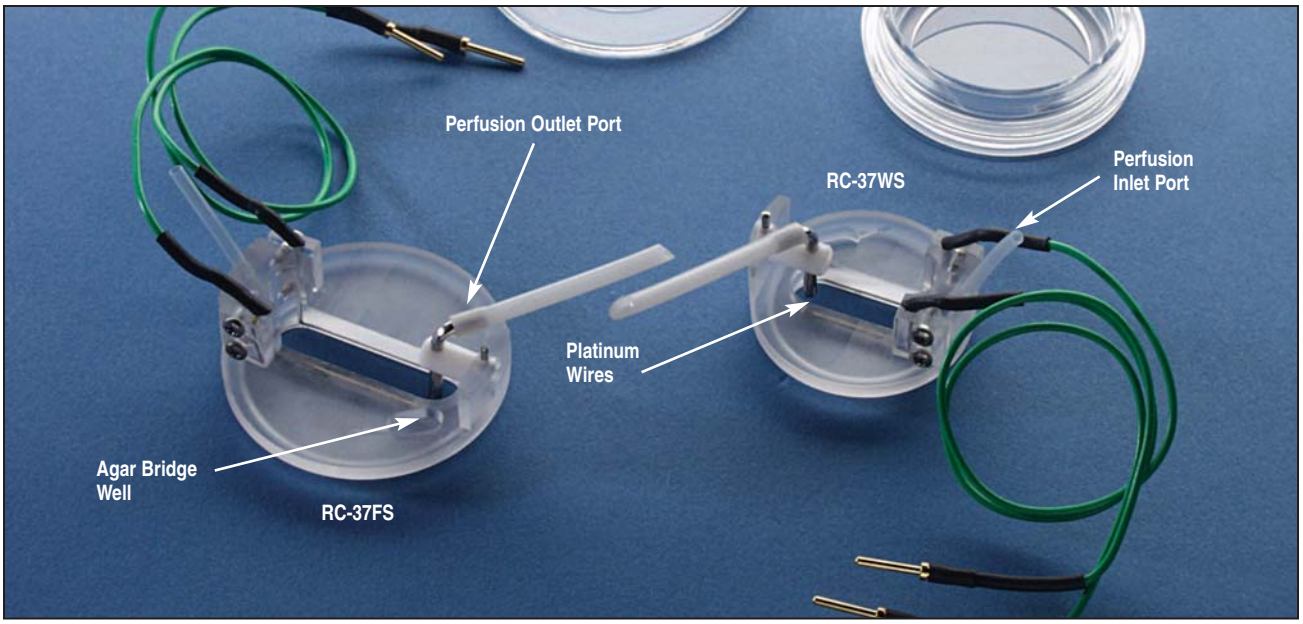
The RC-37WC fits in the Willco Wells dishes while the RC-37FC fits the Falcon and Corning 35 mm dishes. Warner's DH-35 Culture Dish Heater may be used to heat the Corning and Willco Wells 35 mm culture dishes. Falcon 35 mm dishes are compatible with Warner's DH-35i Culture Dish Incubator or the QE-1 Quick Change Heated Base.

Both chambers are supplied with PE-160 Polyethylene Tubing (10 ft.) and tools to remove the top coverslip retainer. The RC37WC is supplied with one box of #1 thickness 15 mm coverslips and the RC37FC is supplied with one box of #1 thickness 18 mm coverslips.



Catalog No.	$	Model	Product
BS4 64-0363		RC-37WC	Chamber Insert Closed for Willco 35 mm Dishes
BS4 64-0364		RC-37FC	Chamber Insert Closed for Falcon/Corning 35 mm Dishes
Accessories/Replacement Parts			
BS4 64-0703		CS15R	Coverslips 15 mm Dia. #1 Thickness, Box of 100
BS4 64-0384		CS18R	Coverslips 18 mm Dia. #1 Thickness, Box of 100
BS4 64-0758		D3522P	Glass Bottom Cell Culture Dishes, pouch of 20
BS4 64-0762		D3522B	Glass Bottom Cell Culture Dishes, pkg. of 120
BS4 64-0378		111-KIT	Silicone Grease Kit with Brushes and Pallets

NEW Models RC-37WS and RC-37FS - Perfusion Chamber Inserts with Field Stimulation



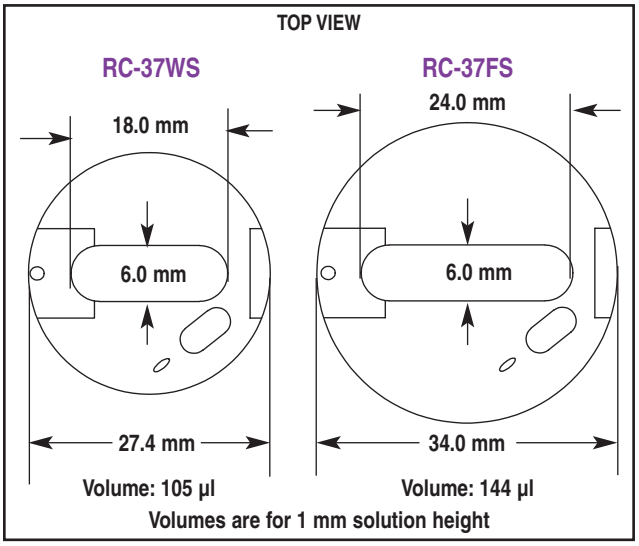
- Designed for glass bottom 35 mm dishes
- Permits imaging and perfusion in the cell culture dish
- Platinum field stimulation electrodes
- Ideal for rapid screening assays

The latest member of the RC-37 family of perfusion chamber inserts is designed for applications requiring field stimulation and includes a pair of platinum electrodes. Both versions feature a slotted bath to promote a laminar solution flow and to ensure an even electrical field.

These models include a perfusion inlet port and a 16 gauge height adjustable aspirator. An agar bridge well has been added to accommodate a bath ground electrode. A thin coating of silicone grease forms the seal between dish and chamber.

The RC-37WS fits in the Willco Wells dishes; the RC-37FS fits the Falcon/Corning 35 mm dishes. Warner's DH-35 Culture Dish Heater may be used to heat the Corning and Wilco Wells 35 mm culture dishes while Falcon 35 mm dishes are compatible with Warner's DH-35i Culture Dish Incubator or the QE-1 Quick Change Heated Base.

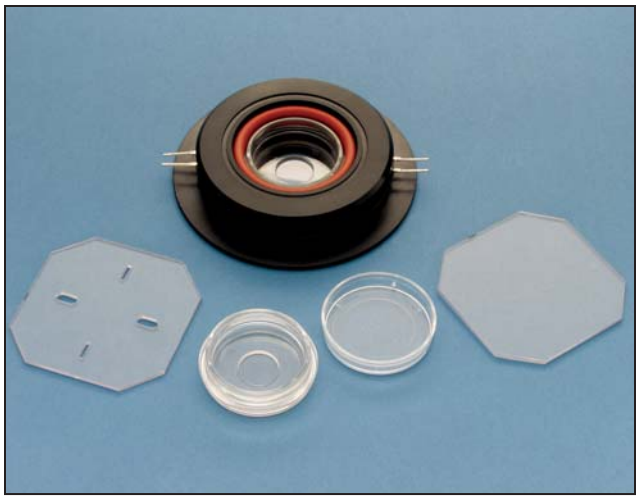
Both chambers are supplied with 10 feet of PE-160 Polyethylene Tubing.



Catalog No.	$	Model	Product
BS4 64-0365		RC-37WS	Chamber Insert Closed for Willco 35 mm Dishes
BS4 64-0366		RC-37FS	Chamber Insert Closed for Falcon/Corning 35 mm Dishes
Accessories/Replacement Parts			
BS4 64-0758		D3522P	Glass Bottom Cell Culture Dishes, pouch of 20
BS4 64-0762		D3522B	Glass Bottom Cell Culture Dishes, pkg. of 120
BS4 64-0378		111-KIT	Silicone Grease Kit with Brushes and Pallets
BS4 64-1424		SIU-102	Stimulus Isolation Unit
BS4 64-1425		CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)

Chambers for 35mm Cell Culture Dishes

NEW Culture Dish Heater DH-35



DH-35 heaters work with Corning 35 mm tissue culture dishes (Corning p/n 25000) and are designed for mounting on most microscopes. The holder is machined in two pieces. The top half is easily removed for replacement of dishes. Dishes can be placed in the holder with or without dish covers. The holder is supplied with two additional holder covers, one of which has openings to allow for perfusion or insertion of probes or electrodes. The base of the holder has a 19 mm diameter aperture. Stage adapters are available for many microscopes, see pages M114 and M115. DH-35 is used with the CC-28 Cable Assembly, see page M126. For 35 mm glass bottom culture dishes, see right.

Catalog No.	$	Model	Product
BS4 64-0110		DH-35	35 mm Culture Dish Heater
BS4 64-0106		CC-28	Cable Assembly
BS4 64-0350		AR-1	Adapter Rin for Willco Dish
Stage Adapters for DH-35		**Stage Adapter**	**Microscope**
BS4 64-0291		SA-NIK	Nikon Diaphot,TE200 & TE300
BS4 64-0295		SA-OLY/2	Olympus IMT-2, IX & BX50WI
BS4 64-0296		SA-20LZ	Zeiss Axiovert
BS4 64-0296		SA-20LZ	Leica DMIRB & DMIL

For other microscopes, please consult our technical support department.

Glass Bottom Cell Culture Dishes (35 and 50 mm)

- Highest quality construction, sterilized
- #1 Cover glass for microscope imaging
- Glass covers complete bottom
- Compatible with DH-35 Dish Heater, see left

High quality polystyrene dishes with No. 1 cover glass bottoms are available in 35 mm and 50 mm diameters. They are available in both pouch pack (20/pouch) and individual blister pack (120/case). All dishes are sterilized before packaging. The 35 mm sizes are compatible with the DH-35 Dish Heater, see left.

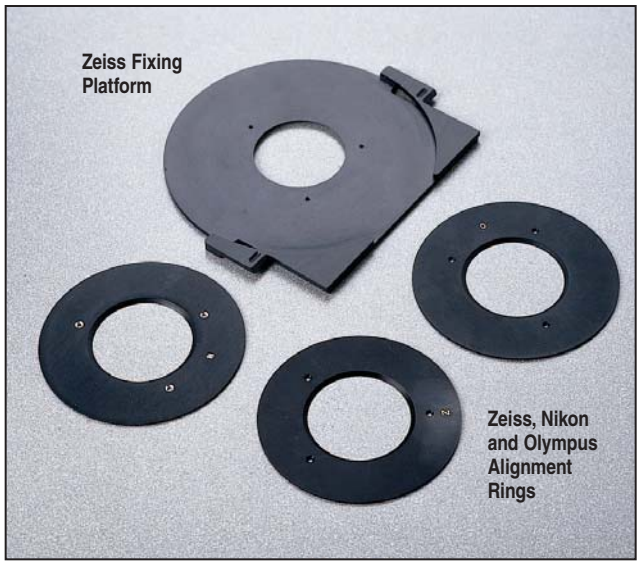
Cover Glasses

Catalog No.	$	Model	Dish Dimensions, D x H	Glass Aperture
Pouch-Pack Dishes, 20 Sterilized Dishes/Pouch				
BS4 64-0757		D3512P	35 x 9.9 mm	12 mm
BS4 64-0758		D3522P	35 x 9.9 mm	22 mm
BS4 64-0759		D5030P	50 x 7.2 mm	30 mm
BS4 64-0760		D5040P	50 x 7.2 mm	40 mm
Blister-Pack Dishes, Individual Packaged Sterile Dishes, Case of 120				
BS4 64-0761		D3512B	35 x 9.9 mm	12 mm
BS4 64-0762		D3522B	35 x 9.9 mm	22 mm
BS4 64-0763		D5030B	50 x 7.2 mm	30 mm
BS4 64-0764		D5040B	50 x 7.2 mm	40 mm

Note: 35 mm Dishes supplied with Triple Vented Lids for optimum ventilation. 50 mm Dishes have low side walls to facilitate microinjection.

For Single and Dual-Channel Heater Controllers, see page M126.

Micro-Incubators Accessories



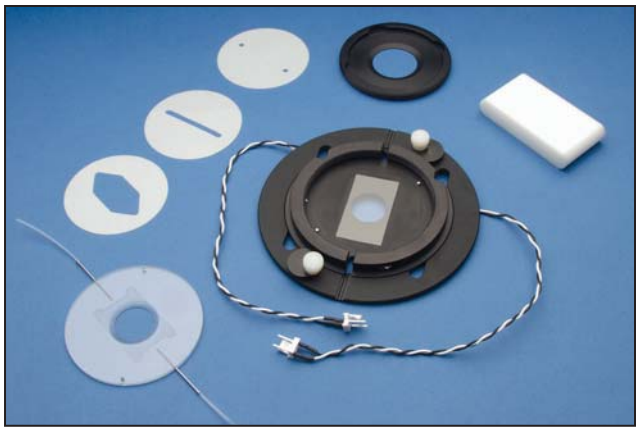
Adapters

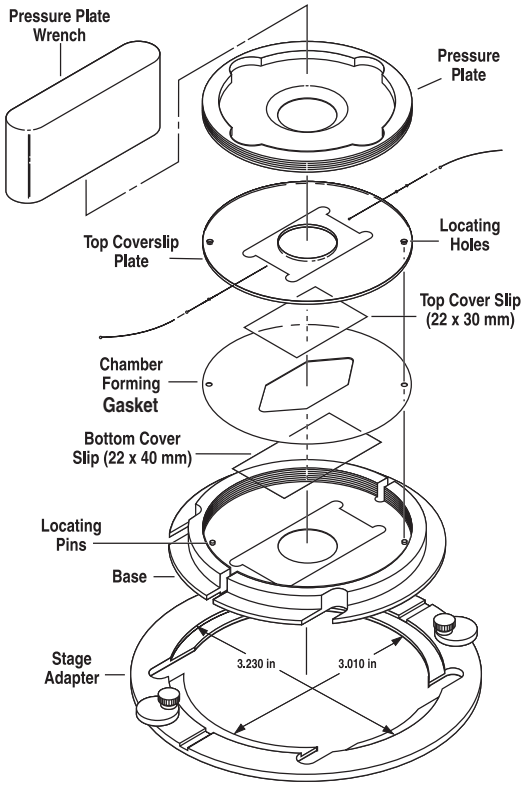
Harvard Apparatus offers a wide range of alignment rings and fixing platforms to adapt micro-incubators to all major microscope brands.

Catalog No.	$	Model	Product
Alignment Rings and Fixing Platforms			
BS4 65-0059		PDMI-ARN	PDMI-2/PSMI Alignment Ring for Nikon Diaphot (Old or 300/200) TMD Stage, 4.242 x .071 in (D x Thickness)
BS4 65-0060		PDMI-ARO	PDMI-2/PSMI Alignment Ring for Olympus IX50/70 or IMT-2 Fixed Stage, 4.320 x .071 in (D x Thickness)
BS4 65-0061		PDMI-ARZ	PDMI-2/PSMI Alignment Ring for Zeiss Axiovert Gliding or Rotary Stages, 4.046 x .071 in (D x Thickness)
BS4 65-0062		PDMI-FPL	PDMI-2/PSMI Fixing Platform for Leica DAS Mikroskop DMIL and DMIRB/E with Attachable Mechanical Stage
BS4 65-0063		PDMI-FPZ	PDMI-2/PSMI Fixing Platform for Zeiss Axiovert with Attachable Mechanical Stage, M-Type Stage
BS4 65-0064		LU-FPL	LU-CB-1 Fixing Platform for Leica DAS Mikroskop DMIL and DMIRB/E with Attachable Mechanical Stage
BS4 65-0065		LU-FPZ	LU-CB-1 Fixing Platform for Zeiss Axiovert with Attachable Mechanical Stage, M-Type Stage
BS4 65-0093		PDMI-ARL	Alignment Ring for Leica Microscope, 88 x 1.8 mm (OD x Thickness)

Catalog No.	$	Model	Product
Miscellaneous			
BS4 65-0047		LU-ASP	Leiden Aspirator, Cover Slip Dish Fluid Level Setting Device, 38 mm H
BS4 65-0052		MI-M	Mini Magnets for Top Surface of Micro-Incubators (LU-CB-1, PDMI-2 or PSMI), set of 4
BS4 65-0053		PS-CSD	Patch Slice Cover Slip Dish for PSMI
BS4 65-0054		LU-PD	Sleeve of 35 mm Petri Dishes, pkg. of 20
BS4 65-0055		BSC-TH	Magnetic Thermistor Holder for LU-CB-1
Thermistors			
BS4 65-0057		BSC-T3	Bath Thermistor for Use with PDMI-2, PSMI, LU-CB1, and TC-202A
BS4 65-0056		BSC-T3A	Bath Thermistor for use with LU-CPC-CEH and TC-202A
BS4 65-0098		BSC-T2	Replacement-Bath Thermistor for Obsolete TC-102
BS4 65-0016		BSC-T2A	Replacement-Bath Thermistor for Use with LU-CPC-CEH and TC-102
BS4 65-0058		PDMI-TUBE	PDMI-2 Copper Cooling Tube Coil (Shaped to Conform to Fin Channel) with Open Ends
Micro-Incubator Replacement Parts			
BS4 65-0066		D-ORING-1	Cover Slip Dish O-Rings Replacement for LU-CSD or MSC-TD, 1 Small (approx. 23.80 mm OD) and 1 Large (approx. 29.80 mm OD), set of 2
BS4 65-0067		D-ORING-2	Cover Slip Dish O-Rings, Replacement for MSC-PTD, 1 Small (approx. 20.80 mm OD) and 1 Large (approx. 29.80 mm OD), set of 2
BS4 65-0068		CS-GLASS-1	Glass Cover Slips (#1) for LU-CSD or MSC-PTD, 0.13 to 0.17 x 25 mm (Thickness x D), pkg. of 100
BS4 65-0069		CS-GLASS-2	Glass Cover Slips (#2) for LU-CSD or MSC-PTD, 0.18 to 0.25 x 25 mm (Thickness x D), pkg. of 100
BS4 65-0070		MI-T	Perfusion/Aspiration Teflon Tubing Replace-ments for PDMI-2/PSMI, 2 ft L x 26 AWG, pkg. of 8
BS4 65-0071		LU-CPC-P	Silicone Rubber Plugs for LU-CPC or LU-CPC-CEH, set of 4
BS4 65-0072		TC-CA	Replacement Output Cable to Connect TC-102 Temperature Controller to LU-CB-1 or LU-CPC-CEH

Confocal Imaging Chamber RC-30





The RC-30 is a low profile chamber with special features for confocal imaging. The chamber bath has a variable volume and fast exchange and is formed with a silicone gasket sandwiched between the top and bottom cover slips. Pre-cut 250 µm thick gasket forms are supplied; one wide cut to use the full aperture window (17.7 mm D), and a slotted version for faster solution exchange. Blank gasket forms are also supplied permitting customized bath shape required for the application. Gaskets with 375 µm thickness are also available. The bath has a large viewing area with an aperture of 17.7 mm D. The chamber bottom is beveled to permit maximum access to the bottom coverslip. The chamber is reversible and may be mounted in the stage adapter to accommodate both upright and inverted microscopes. The RC-30HV is an optional heater version, which includes a pair of resistive heaters mounted to the chamber base. Heaters are compatible with Warner TC324B / TC344B Heater Controllers, see page M126.

These Confocal Imaging Chambers are supplied with six pre-cut 250 µm thick gaskets, two large baths (133 µl volume), two slotted baths (25.6 µl volume), two blank for customized coverslips (22 x 30 mm #1 and 22 x 40 mm #1), pkg. of 50 each, and PE-90 Tubing (3.3 m).

Specifications

Physical Dimensions	9.5 x 82 mm D
Weight	<90 g, assembled with optional heaters
Base and Pressure Plate	Aluminum, black anodized
Top Coverslip Plate	Polycarbonate
Gaskets	Silicone Rubber
Input/Output Tubing	PE-90
Coverslips (#1)	**Top:** 22 x 30 mm; **Bottom:** 22 x 40 mm

Catalog No.	$	Model	Product
BS4 64-0320		RC-30	Confocal Imaging Chamber
BS4 64-0321		RC-30HV	Confocal Imaging Chamber with Heaters
Optional Accessories			
BS4 64-0322		SA-30NIK	Stage Adapters for Nikon Diaphot/TE200/TE300*
BS4 64-0323		SA-30TMS8	Stage Adapters for Nikon TMS with 8 x 12 cm Cutout*
BS4 64-0324		SA-30TMS9	Stage Adapters for Nikon TMS with 9 x 13 cm Cutout*
BS4 64-0325		SA-30/OLY2	Stage Adapters for Olympus IMT-2/IX50/IX70/BX50WI*
BS4 64-0326		SA-30LZ w/	Stage Adapters for Zeiss Axiovert* 211 x 230 Specimen Stage
BS4 64-0327		SA-30KZ w/	Stage Adapters for Zeiss Axiovert* 85 x 130 Mechanical (K) Stage
BS4 64-0326		SA-30LZ	Stage Adapters for Leica DMIRB/E with Plane Stage*
BS4 64-0328		SA-30L3P	Stage Adapters for Leica MIRB/E with 3-Plate Mechanical Stage*
BS4 64-0329		SA-30PLI	For Prior & Ludl Motorized Stage*
BS4 64-0330		GS-30L/10	Replacement Gaskets for Large Bath, 250 µm Thickness, pkg. of 10
BS4 64-0331		GS-30L/15	Replacement Gaskets for Large Bath, 375 µm Thickness, pkg. of 10
BS4 64-0332		GS-30S/10	Replacement Gaskets for Slotted Bath, 250 µm Thickness, pkg. of 10
BS4 64-0333		GS-30S/15	Replacement Gaskets for Slotted Bath, 375 µm Thickness, pkg. of 10
BS4 64-0334		GS-30B/10	Replacement Gaskets for Blank, 250 µm Thickness, pkg. of 10
BS4 64-0335		GS-30B/15	Replacement Gaskets for Blank, 375 µm Thickness, pkg. of 10
BS4 64-0341		GS-30B/4	Replacement Gaskets for Blanks, 150 µm Thickness, pkg. of 10
BS4 64-0342		GS-30L/4	Replacement Gaskets for Large Bath, 150 µm Thickness, pkg. of 10
BS4 64-0343		GS-30S/4	Replacement Gaskets for Slotted Bath, 150 µm Thickness, pkg. of 10

**Note: see pages M114 and M115 for Stage Adapter drawings. Exterior dimensions for corresponding models (SA-20 vs SA-30) are identical.*

NEW Model RC-50 Imaging Chamber for Transepithelial Studies

- Low profile, Horizontally Mounted Ussing Chamber
- Custom round or slotted apertures to accommodate a variety of tissues sizes
- Excellent optical access
- Accommodates both upright and inverted microscopes

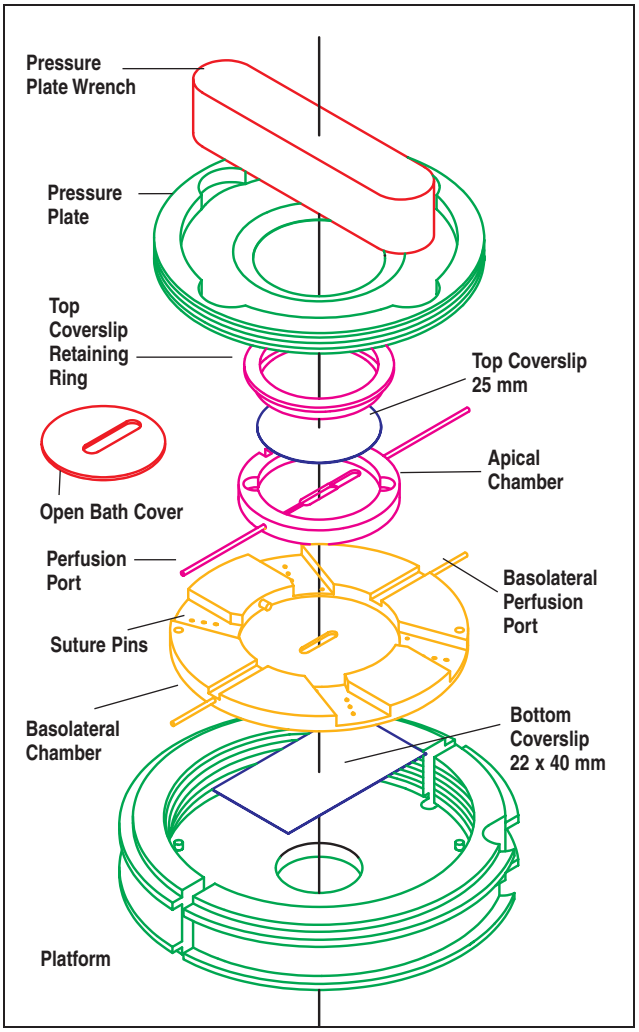
The RC-50 is a low profile, horizontally mounted Ussing chamber incorporating special features for using confocal imaging. The chamber can be configured as a closed perfusion system using either gravity or pump feed. The apical (upper) surface of the chamber can be used in an open or closed configuration. The basolateral chamber has been designed to facilitate placement and stretching of hard to handle tissue such as trachea. Suture pins are provided to act as anchor points for suture lines.

A #1 glass coverslip forms both the top and bottom of the chamber, allowing it to be used with both inverted and upright microscopes. While the chamber bottom is beveled to permit maximum access to the bottom coverslip, the chamber body can also be inverted to allow access to the other side. The viewing aperture in the chamber basolateral section is 17.7 mm in diameter and the viewing aperture in the chamber apical section is 22.8 mm.

The RC-50 includes a pair of resistive heater elements mounted to the chamber base. Heater elements are compatible with Warner TC-324B and TC-344B Heater Controllers.

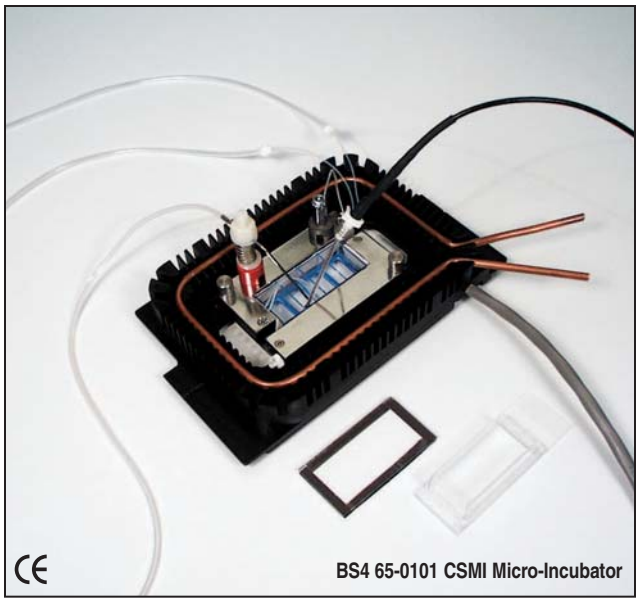
Specifications

Physical Dimensions	12.4 mm H x 82 mm D
Weight	<110 g, assembled with heaters
Platform and Pressure Plate	Aluminum, black anodized
Coverslip Plates	Polycarbonate
Input/Output Tubing	PE-90
Coverslips (#1)	Top: 25 mm; Bottom: 22 x 40 mm



Catalog No.	$	Model	Product
BS4 64-0605		RC-50	Confocal Imaging Chamber
Optional Accessories			
BS4 64-0322		SA-30NIK	Stage Adapters for Nikon Diaphot/TE200/TE300
BS4 64-0323		SA-30TMS8	Stage Adapters for Nikon TMS with 8 x 12 cm Cutout
BS4 64-0324		SA-30TMS9	Stage Adapters for Nikon TMS with 9 x 13 cm Cutout
BS4 64-0325		SA-30/OLY2	Stage Adapters for Olympus IMT-2/IX50/IX70/BX50WI
BS4 64-0326		SA-30LZ	Stage Adapters for Zeiss Axiovert 211 x 230 Specimen Stage
BS4 64-0327		SA-30KZ	Stage Adapters for Zeiss Axiovert 85 x 130 Mechanical (K) Stage
BS4 64-0326		SA-30LZ	Stage Adapters for Leica DMIRB/E with Plane Stage
BS4 64-0328		SA-30L3P	Stage Adapters for Leica DMIRB/E with 3-Plate Mechanical Stage
BS4 64-0329		SA-30PLI	For Prior & Ludl Motorized Stage

Harvard/Medical Systems Microscope Stage Incubators



BS4 65-0101 CSMI Micro-Incubator

Harvard Apparatus, Inc. offers a comprehensive line of versatile Micro-Incubators and cell/tissue holding chambers for use on the stages of microscopes. These Micro-Incubators allow researchers to control temperature and pH, thus significantly increasing the viability of the tissue culture. Whether you have an inverted or upright microscope, it is possible to achieve media heating and/or cooling under static or dynamic conditions. We also have Micro-Incubators that work in either an open or gas tight environment.

Four different Micro-Incubators and three different companion chambers are described on the following pages including our new CSMI micro-incubator for rectangular slides. In addition, we offer a fifth micro-incubator system, our model PSMI, for customers in need of the shallow depths and low angles of attack typically required for patch slice studies. The TC-202A temperature controller, see page M125, is available which is perfectly matched to the heating and cooling requirements of all the Micro-Incubator systems.

CSMI Chambered Slide Micro-Incubator

- Ideal for use with rectangular chambered slides and chambered coverglass
- Provides comprehensive micro-environment maintenance, controlling pH, temperature, perfusion and gas atmosphere
- Using Peltier heat pump, heats and cools over ~5° to 50°C temperature range
- Accommodates up to 4 pre-temperature regulated perfusion lines
- Provides temperature regulated gas superfusion
- Magnetic base for easy setup of different configurations
- Perfusate removal with minimal disturbance of fluid level using a unique aspirator

The CSMI is a versatile microscope stage-incubator for cell/tissue culture work. It is designed to accommodate new rectangular disposable Chamber Slides™ and Chambered Coverglass from the Nunc Lab-Tek® series, and the Falcon® Cultureslide series from Beckton Dickinson. The CSMI, in combination with a matching low noise TC-202A temperature controller, facilitates long term maintenance of tissue or cell cultures on a microscope stage. This allows optical monitoring of dyes, micro-injection, electrical recording, and micro-manipulation for many hours or even days.

The CSMI not only facilitates the precise regulation and manipulation of bath temperature, but also supports multi-channel perfusion (up to 4 channels) and gas atmosphere maintenance, such as CO_2 superfusion for pH control. The CSMI is based on a successful design of the Medical Systems PDMI-2 micro-incubator for 35 mm Petri dishes. The CSMI utilizes a Peltier thermo-electric device to regulate temperature over a wide range both above and below ambient levels. Lower temperatures (approximately 10ºC below ambient) may be obtained by using an optional cooling tube.

The CSMI fits on the stage of inverted microscopes from major microscope manufacturers including Zeiss, Nikon, Olympus and Leica. Harvard Apparatus offers custom-made rectangular adapters to these microscopes.

Specifications

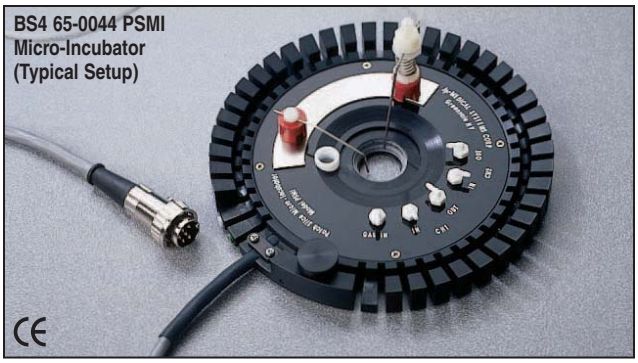
Temperature Range	~5° to 10°C below ambient to 50°C without water cooling
Disposable Chambers Accommodated	1. Nalge Nunc chambered slides & cover slips 2. Becton Dickinson Falcon chambered slides
Microscopes Accommodated	1. Zeiss Axiovert with attachable mechanical stage 2. Leica DAS Microscope DMIL and DMIRB/E with attached mechanical stage 3. Nikon Diaphot 4. Olympus IX50/70 or IMT-2 fixed stage
Peltier TED Current Rating	6 A DC max
Built In Plate Thermistor	100 kΩ at 25°C — YSI 44011
Perfusion Inlet Lines	26 AWG Teflon capillary up to 4 lines can be installed simultaneously
Perfusion Rate	3 ml/min nominal total
Perfusate Outlet	LU-ASP aspirator
Gas Port	1/16 in. barb
Gas Superfusion Rate	0.5 to 2.0 L/min
Weight	17.9 oz (0.5 kg)
Overall Dimensions	6.5 x 4 x 1 in (16.5 x 10.2 x 2.5 cm)

Catalog No.	$	Product
BS4 65-0101		CSMI Chambered Slide Micro-Incubator
BS4 65-0045		TC-202A Bipolar Temperature Controller, see page M125
BS4 65-0103		Copper Cooling Tube for CSMI

For TC-202A Bipolar Temperature Controller, see page M125.

For pH Controller, see page M144.

PSMI Patch Slice Micro-Incubator



- Small entry angles ideal for patch slice recordings
- Shallow fluid level minimizes pipette capacitance
- Heats & Cools
- ~5° to 50°C
- Peltier heat pump
- Maintains cell conditions for hours

The Patch Slice Micro-Incubator System provides a complete solution to the challenge of electrophysiological study of synaptic slice connections at physiological temperatures using low noise whole cell patch recording either with or without water immersion of the microscope objective in the recording medium.

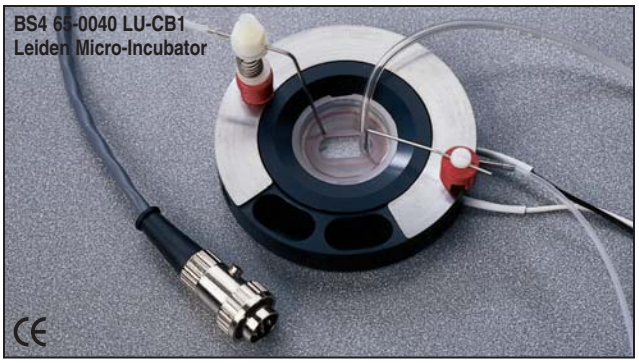
This micro-incubator is a shallow, annular assembly which surrounds the central slice holding dish. Room temperature perfusant is delivered to the incubator which in turn delivers it to the dish at a precisely controlled temperature you select. The perfusant is removed (via user supplied suction) by an included, height adjustable aspirator (LU-ASP). Two independent channels of perfusant flow through the PSMI into the chamber via replaceable plastic tubing of low volume (<100 µl) to allow rapid switching of media via an upstream valve for pharmacological studies. A separate gas inlet provides temperature controlled gas across the dish. The TC-202A provides temperature control (~5° to 50°C) using the micro-incubator warming/cooling plate as the control point. Lower temperatures (approximately 10ºC below ambient) may be obtained by using an optional cooling tube. The cover slip dish (PS-CSD) consists of two 22 mm diameter cover slips held in a circular frame. The slice sits on the top cover slip with the immersion objective reaching the fluid surface. The bottom cover slip prevents condensation for optimal illumination and viewing. To enable placement of the patch electrode, entry angles as small as 15° can be achieved for slice access.

Specifications

Chamber Type	PS-CSD Cover Slip Dish
Temperature Stability	±0.2°C with TC-202A, at 37°C with 1 ml/min perfusion
Temperature Gradient	Across chamber: 2°C with 1.5 ml media volume, 1 ml/min
Temperature Range	5°-10°C below ambient to 50°C without water cooling
Built In Temp. Sensor	Thermistor type: 100 kΩ at 25°C YSI 44011
Peltier Device	Current rating: 6 A max
Media Perfusion Rates	Up to 3.0 ml/min
Dimensions, H x Dia	17 x 152 mm (0.67 x 6.0 in), overall
Weight	0.5 kg (17.9 oz)

Catalog No.	$	Product
BS4 65-0044		PSMI Patch Slice Micro-Incubator with PS-CSD
BS4 65-0109		Copper Cooling Tube for PSMI

LU-CB1 Leiden Micro-Incubator



- Ambient to 50°C
- Designed by top teachers at Leiden University
- Proven design in use for nearly two decades
- Open design for easy cell access

The LU-CB1 Leiden Micro-Incubator provides stable culture conditions (temperature, pH, aseptic isolation, and osmolarity) during continuous or intermittent observations when media temperatures between ambient and 50°C are desired.

The LU-CBl is used primarily for static (no perfusion) chamber media applications. It features excellent mechanical and optical access to cells or tissue. Measuring probes (temperature, pH, etc.), recording electrodes, and micropipettes can easily be manipulated in and out of the chamber.

Aseptic isolation of the culture media can be provided by using a layer of non-toxic mineral oil. A gas flow is directed over the oil to control the micro-environment (including pH) and to minimize temperature gradients across the chamber. It is possible to use the LU-CB1 as a perfused system by preheating the perfusate close to the desired temperature before it enters the chamber.

Specifications

Chamber Options	Coming 35 mm Petri dishes, LU-CSD, MSC-TD or MSC-PTD
Recommended Gas Flow	0.5 to 2.0 L/min
Temperature Range	Ambient to 50°C when used with TC-202A
Temperature Stability	±0.2°C when used with TC-202A
Temperature Gradient Across Chamber	±0.3°C, gas flow of 1.5 L/min, 3.5 ml media volume
Heating Element	2.0 Ω Nichrome Coil
Dimensions, H x D	16 x 90 mm (0.63 x 3.54 in), overall
Weight	150 g (5.3 oz)
Microscope Stage Mounting	Call Harvard Apparatus, Inc. for options

Catalog No.	$	Product
BS4 65-0040		LU-CB1 Leiden Micro-Incubator, with BSC-TH, Tissue Pins, and 3 Alignment Rings (Nikon, Olympus and Zeiss) and Output Cable
BS4 65-0045		TC-202A Bipolar Temperature Controller
BS4 65-0100		Output Cable TC-202A to Microincubator

For pH Controller, see page M144.

LU-CPC-CEH Leiden Closed Perfusion Micro-Incubator

- Sealed gas type chamber
- Controls atmospheric conditions: PO_2 and O_2
- Ambient to 50° C
- 8 ports for perfusion or sensors

This micro-incubator features a short optical path between coverslips to allow single cell fluorescence measurements under maximum objective magnification using either an inverted or upright microscope. Media access is flexible. Four symmetrically placed ports are provided with plugs which are designed so that direct streaming of perfusate onto the cells is avoided. Plug rotation creates different degrees of mixing. There are four additional ports for inserting special purpose probes (e.g. temperature, pO_2) or hypodermic needles to introduce reagents rapidly.

The Leiden closed perfusion micro-incubator uses a nichrome heating element which surrounds the chamber. It requires the TC-202A Temperature Controller. Micro-incubator supplied with output cable and temperature probe.

Specifications

Cover Slips	#1 or 2, 25 mm D (Model # CS-GLASS-1 or CS-GLASS-2)
Distance Between Cover Slips	14 mm (0.55 in)
Temperature Range	Ambient to 50°C with TC-202A
Heating Element	2.0 Ω Nichrome heating coil
Fluid Inlets/Outlets	4 (0.83 X 2.36 in)
Other Inlets for Probes	4 (0.83 X 2.36 in)
Dimensions, H x D	21 x 60 mm (0.83 x 2.36 in)
Weight	60 g (2.1 oz)
Dish Material	Eriflon™ and Stainless Steel

Catalog No.	$	Product
BS4 65-0041		LU-CPC-CEH Leiden Closed Perfusion Micro-Incubator Chamber with Heating

Silicone Grease Kit

We have determined that an effective method of applying silicone lubricant used to form a seal between the coverslip and chamber is an artist's acrylic brush. With that in mind, we have put together a convenient package that includes a tube of Dow Corning® 111 Valve Lubricant & Sealant, #2 and #4 brushes and several pallets to aid in applying the grease.

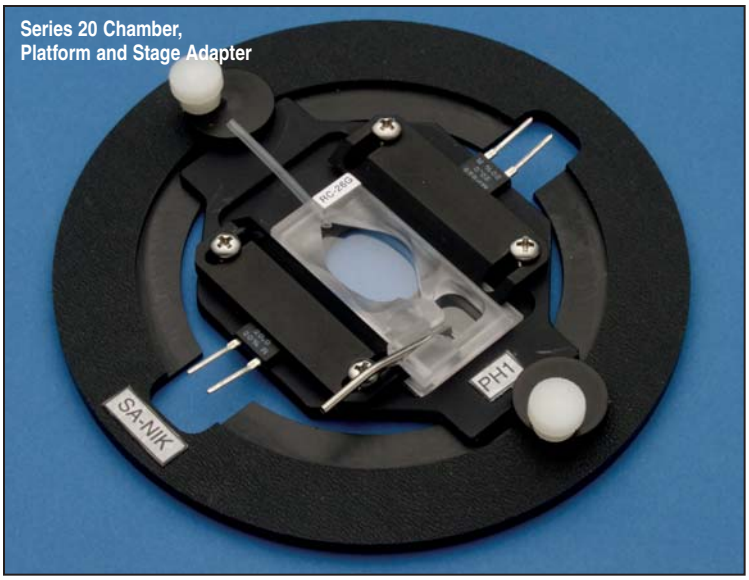
Catalog No.	$	Model	Product
BS4 64-0378		111-Kit	Silicone Grease Kit with Brushes and Pallets

NEW Silicone Lubricant

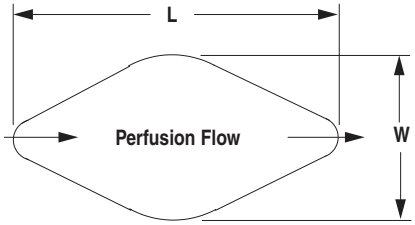
Sealing between coverslip and chamber is most often done with a high purity silicone lubricant such as stopcock or vacuum grease. The Dow Corning® 111 Valve Lubricant & Sealant retains viscosity at elevated temperatures better than others we tested. The 111 sealant is particularly recommend for heated perfusion systems.

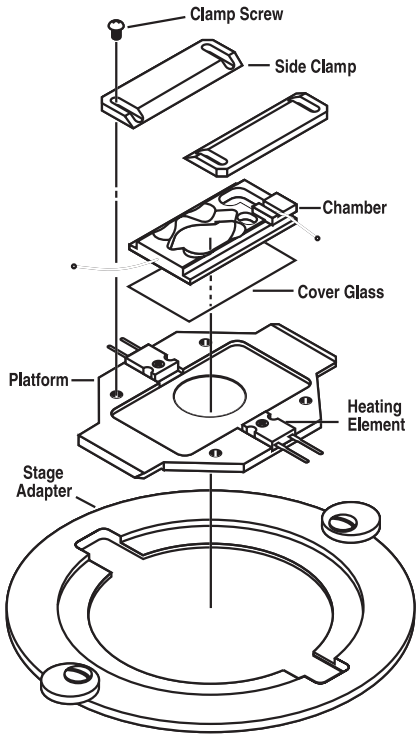
Catalog No.	$	Product
BS4 64-0275		Silicone Lubricant

Series 20 Perfusion Chambers for Imaging and Recording



- View thru single coverslip
- Laminar perfusion flow
- Small volumes, fast exchange
- Use with most microscopes
- Open and closed bath types





Assembly of Chamber

The chamber is prepared by applying a thin bead of vacuum grease to the chamber bottom. The sample coverslip (sample side up) is then attached to the chamber. This assembly is then placed in the platform and clamped to provide a seal between coverslip and chamber. Mounting on the microscope is done with the appropriate stage adapter. The installation is completed by connecting the perfusion lines and any heater cabling required.

Assembly of the closed type chambers includes installation of the top coverslip which precedes the steps outlined above.

Modular Design

Series 20 chambers are a family of models designed to fill a large number of imaging and recording needs. The modular design consists of two parts; a polycarbonate chamber (insert) and an aluminum platform (holder). The platform clamps the chamber providing a seal between the chamber and coverslip. Heater type platforms are used where chamber warming is required. The design of the platforms permits quick removal of the chamber for exchange of the coverslip. A variety of bath sizes and shapes are offered to provide a ready solution to many research requirements. Most models are stocked in depth for fast delivery.

Single Coverslip Design

A common feature of Series 20 chambers is the use of a disposable coverslip as the bottom or floor of the chamber. In many cases, this same coverslip will contain the cells to be studied. Thus, when used with an inverted microscope, the image is viewed through a single #1 coverslip thickness, nominally 0.15 mm.

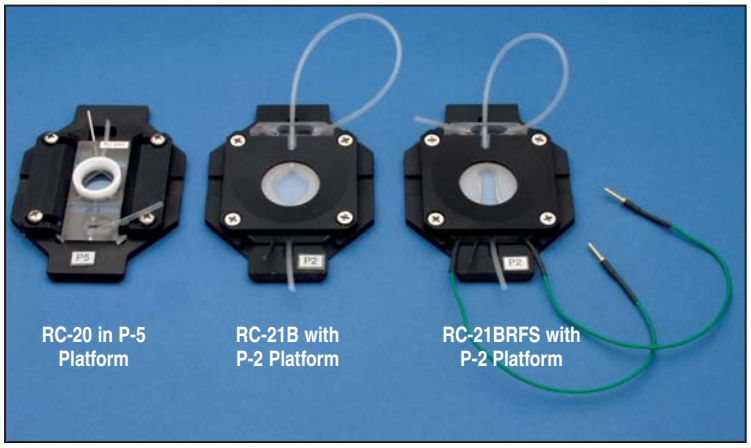
Laminar Flow-Fast Exchange

A diamond-shape bath is used in many Series 20 chambers (models thru RC-26) to provide a linear solution flow. Studies performed at Yale and Stanford Universities showed that this shape produced a laminar flow across the bath. The general shape is shown below and specific dimensions are provided in the following pages. In general, the lower the ratio of bath width (W) to length (L), the better the flow characteristics. Models with small bath volumes can have exchange times measured in seconds even with flow rates less than 1 ml/min. Newer models starting with RC-27 use a slotted bath shape. They are designed for slice studies and other applications requiring a larger bath size.

Perfusing the Chambers

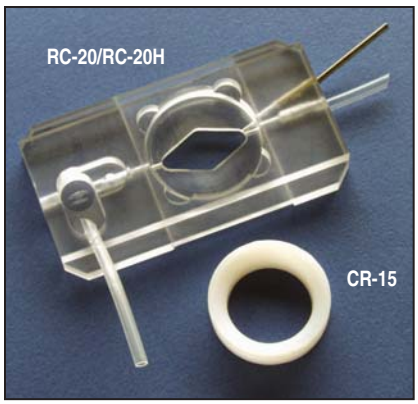
Perfusion can be a pump-driven or gravity-fed system. Flow rates of 10 ml/min or greater are possible but flows of 0.5 to 5 ml/min are the norm. Standard PE-160 polyethylene tubing (or equivalent) inserts directly into the input port. Solutions are removed by suction with either a vacuum source or pump. Open bath chambers are equipped with a stainless steel suction tube which is adjustable for control of solution height. Multiple perfusion lines can be connected to the chambers by using one of the MP or MPP Series manifolds, see page M140.

Series 20 Closed Bath Imaging Chambers



Series 20 Imaging Chambers use coverslips at both top and bottom to enclose the bath area. The closed bath promotes an even and continuous solution exchange and eliminates changes in focus due to alterations in bath height. Studies involving physiological bicarbonate buffers can be performed with no gas loss at the chamber interface. The closed design allows the use of permeable supports. With a laminar flow, minimal distortion of the support will occur. Closed chambers have been used in fluorescent, calcium and time-lapse imaging studies.

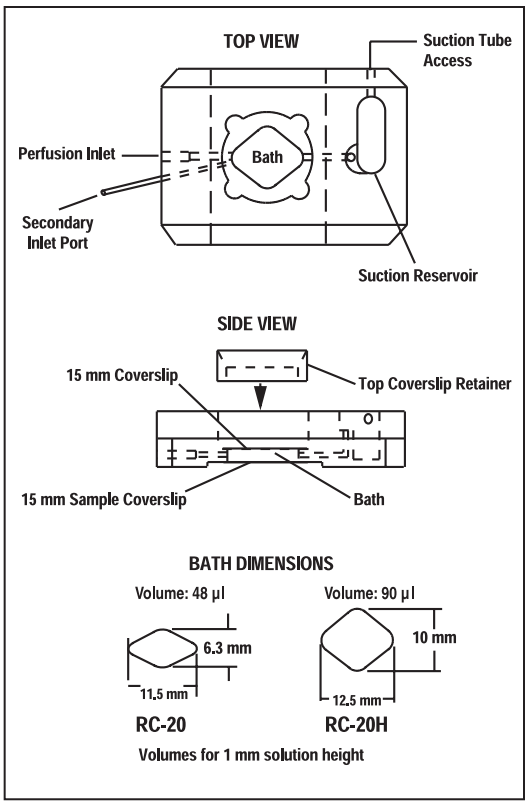
All series 20 chambers equipped with a stainless steel suction tube now include a suction tube clamp. This insures the adjustable tube will not move once the solution height is set. For Series 20 Chamber replacement parts, see page M117



Small Volume Imaging Chambers RC-20 (48 µl) & RC-20H (90 µl)

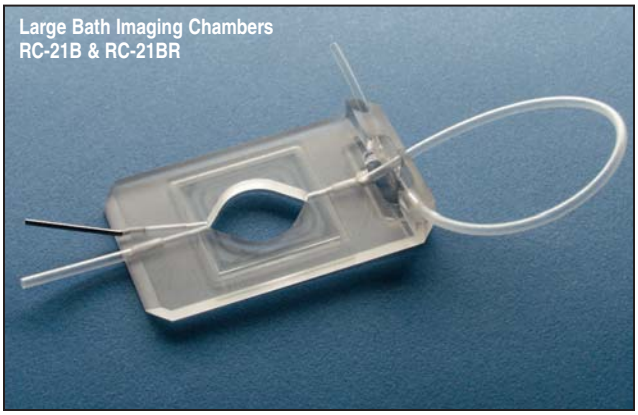
RC-20 and RC-20H are very small volume imaging chambers featuring fast perfusion exchange and short working distance. Two 15 mm diameter coverslips enclose the bath. Distance between top and bottom coverslips is 1 mm. The top coverslip is held in place with a retainer. The sample coverslip is placed on the chamber bottom and the assembled chamber is placed in the chamber platform.

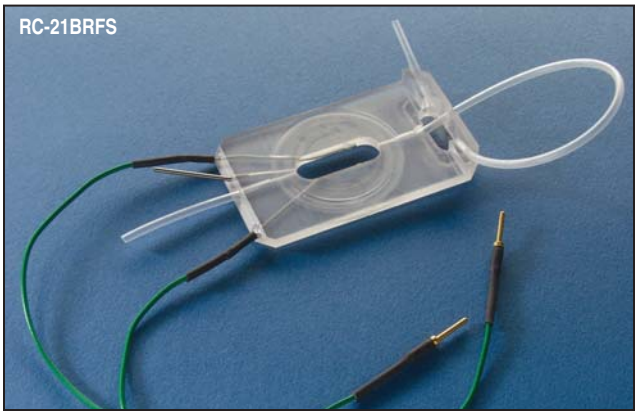
Two bath sizes are available. The smaller and narrower bath of the RC-20 insures a linear flow and fast solution exchange while the larger RC-20H provides a larger viewing area The additional port at the bath input may be used to inject substances into the bath or to remove gas bubbles. Order with P-5 or PH-5 platform, see page M112.

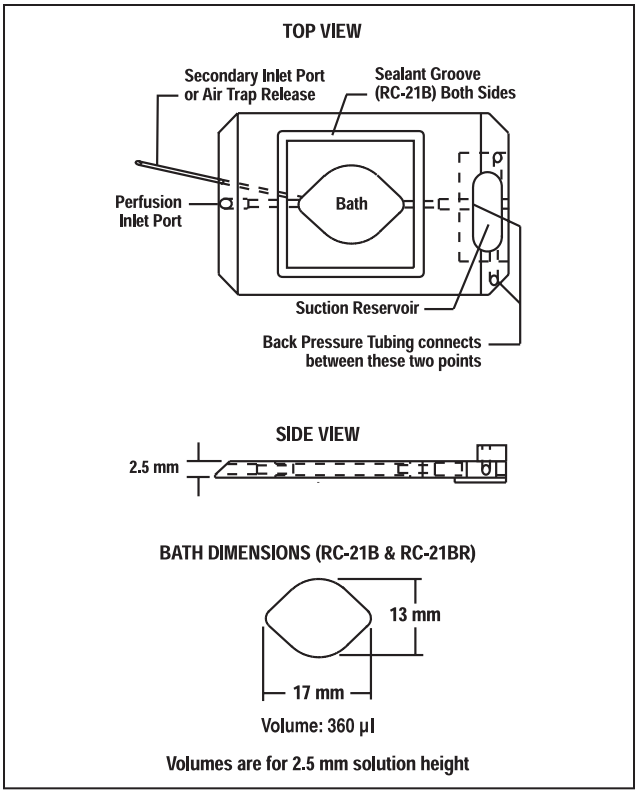


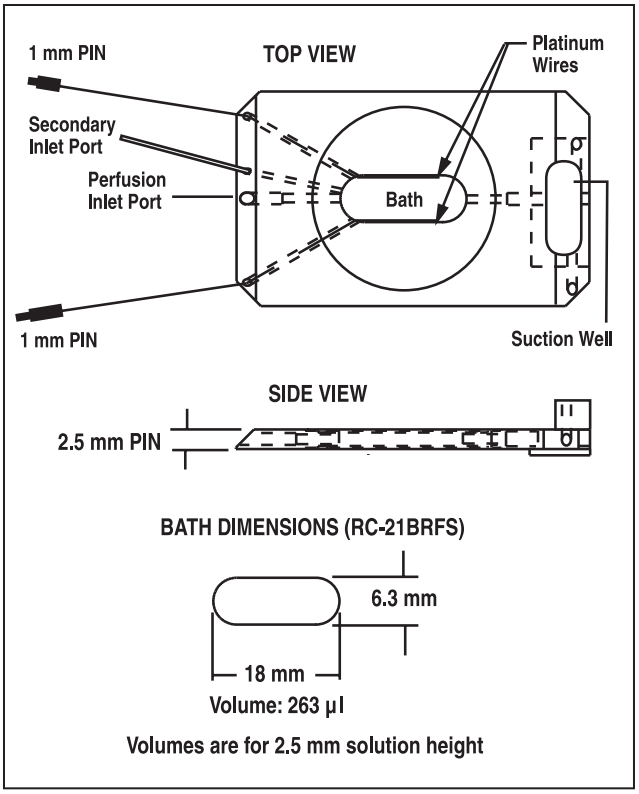
Catalog No.	$	Model	Product
BS4 64-0222		RC-20	Small Volume Imaging Chamber, 48 µl
BS4 64-0223		RC-20H	Small Volume Imaging Chamber, 90 µl
BS4 64-0276		CR-15	Replacement Retaining Ring

Series 20 Closed Bath Imaging Chambers









Large Bath Imaging Chambers RC-21B & RC-21BR (360 µl/2.5 mm)

These chambers provide a large viewing area and good access for microscope optics at chamber top and bottom. The chambers are identical except for the coverslips used; 22 mm square for RC-21B and 25 mm round for RC-21BR. Distance between top and bottom coverslip is 2.5 mm. Bath volume is 360 µl for 2.5 mm of solution. An additional port at the bath input may be used to inject substances or for removing bubbles. At the bath output, a length of tubing is used as a back pressure control to insure a smooth perfusion flow. Order with P-2 or PH-2 platform, see page M112.

Catalog No.	$	Model	Product
BS4 64-0224		RC-21B	Large Bath Imaging Chamber
BS4 64-0225		RC-21BR	Large Bath Imaging Chamber

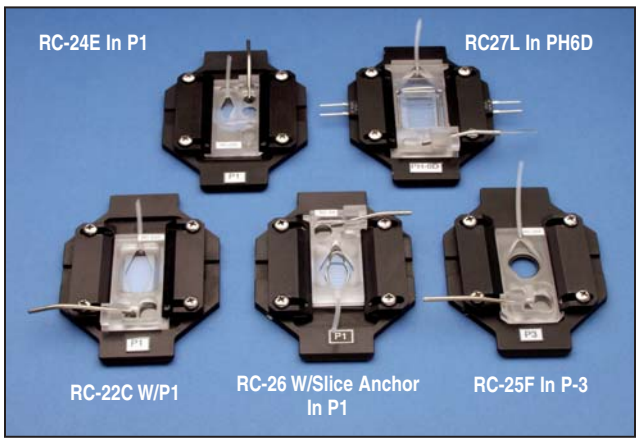
Imaging Chamber with Field Stimulation RC-21BRFS (263 µl/2.5 mm)

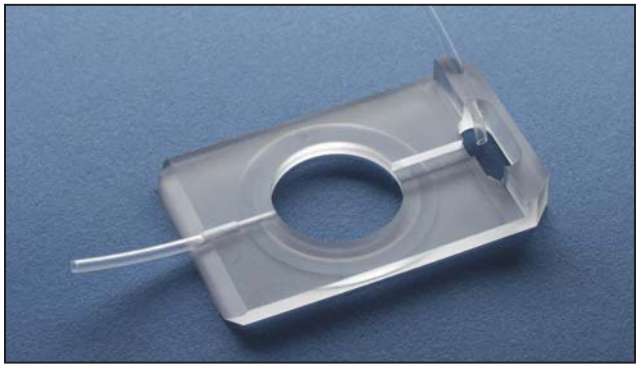
RC-21BRFS is an imaging chamber with field stimulation electrodes. A pair of platinum wires is epoxied into the parallel sides of the oval-shaped bath. The connecting wires are terminated in 1 mm pins. The chamber uses a pair of 25 mm round coverslips. Bath volume is 260 µl for 2.5 mm of solution. The additional port at the chamber perfusion input may be used for removing bubbles or injecting a substance. At the bath output, a length of tubing is used as a back pressure control to insure a smooth perfusion flow. Order with P-2 or PH-2 platform, see page M112.

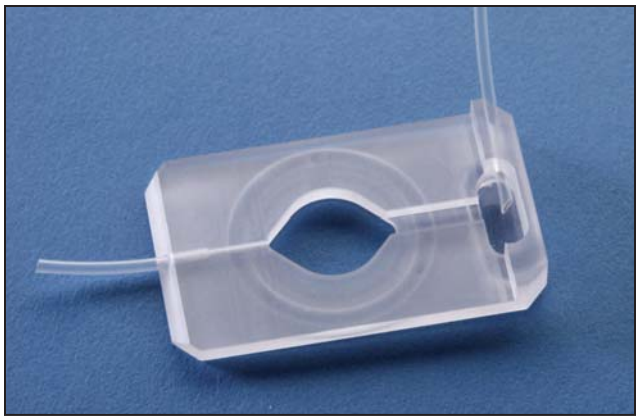
Catalog No.	$	Model	Product
BS4 64-0226		RC-21BRFS	Imaging Chamber with Field Stimulation

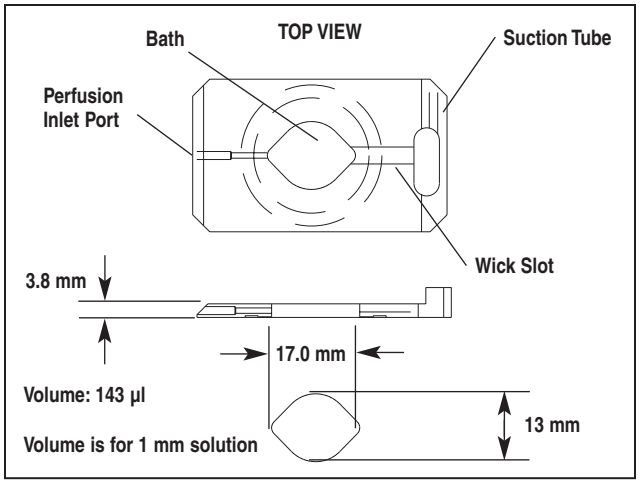
Series 20 Open Bath Recording/Imaging Chambers

Open bath models are designed for electrophysiological recording and/or optical imaging, and are used in applications including patch clamp, oocyte clamp, and physiological measurements on cell cultures and tissue preparations. The low profile design permits good electrode access to the bath. Agar bridge wells for reference electrodes are provided.









NEW Chamber for 25 mm Round Coverslip RC-21BRW (240 µl)

The RC-21BRW is a new addition to the Series 20 family. It is an open chamber using the popular 25 mm round coverslip. Constant solution level and quiet operation are assured with the use of a wick between the bath and suction well. RC-21BRW is used with either the P-2 or PH-2 platform, see page M112. Bath volume is 240 µl for 1 mm solution height.

Catalog No.	$	Model	Product
BS4 64-0227		RC-21BRW	Open Chamber for 25 mm Round Coverslip
BS4 64-0278		P-2	Platform
BS4 64-0285		PH-2	Heater Platform

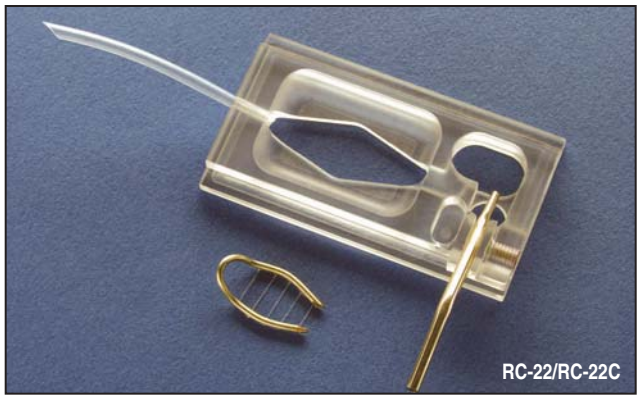
Model RC-21BDW Chamber for 25 mm Round Coverslip (143 µl)

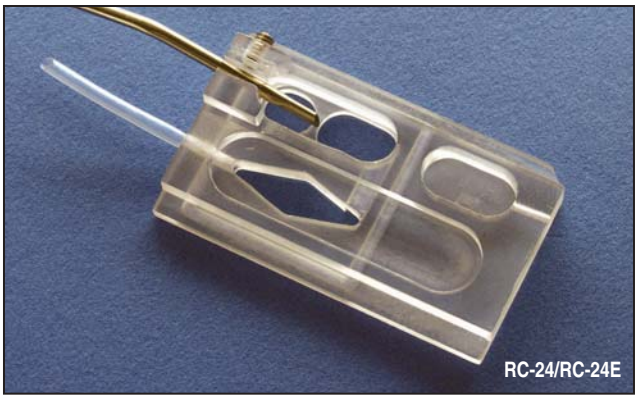
- Diamond-shaped bath for a linear solution flow
- Open chamber using 25 mm coverslips
- 143 µl bath volume for 1 mm solution height

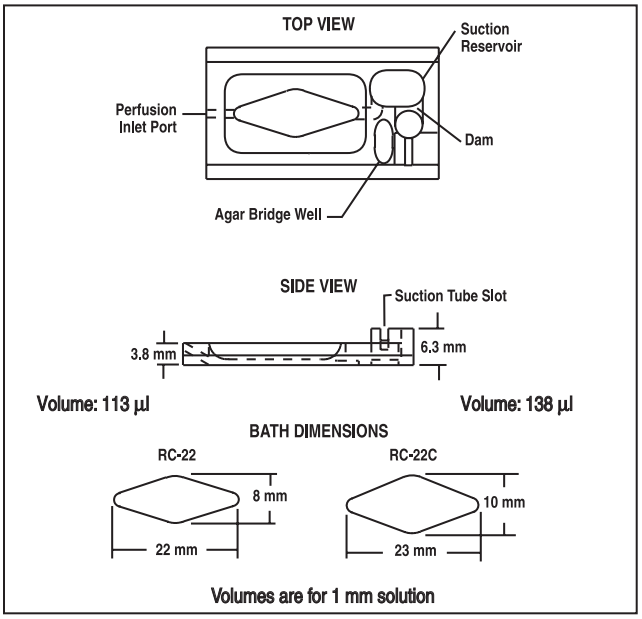
The RC-21BDW is an open chamber using the popular 25 mm round coverslip. Constant solution level and quiet operation are assured with the use of a wick between the bath and suction well. The RC-21BRW is used with either the P-2 or PH-2 Platform. Bath volume is 143 µl for 1 mm solution height. Standard accessories supplied are 25 mm #1 coverslips and PE-160 Tubing (10 ft.).

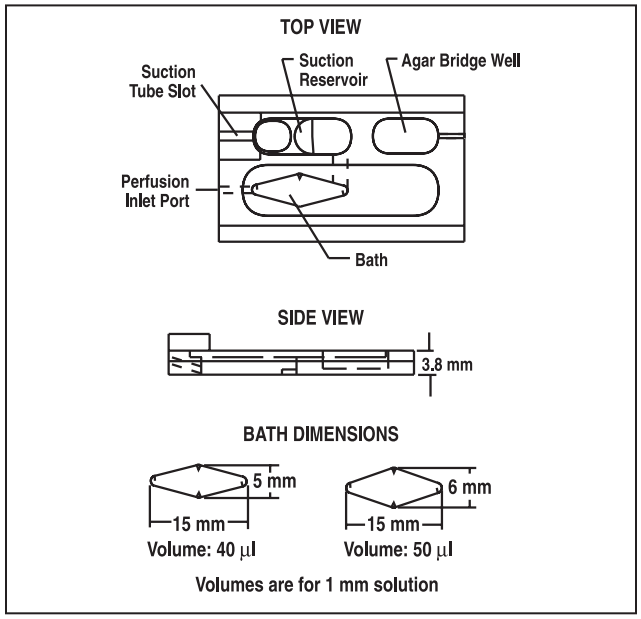
Catalog No.	$	Model	Product
BS4 64-0362		RC-21BDW	Open Chamber for 25 mm Round Coverslips
Accessories/Replacement Parts			
BS4 64-0705		CS25R	Coverslips 25 mm Dia. #1 Box of 100

Series 20 Open Bath Recording/Imaging Chambers









Recording Chambers for Tissue Slice RC-22 (113 µl) & RC-22C (138 µl)

Small bath chambers for tissue and brain slice studies. Slices are held down with stainless steel anchors with lycra threads at 1.5 mm spacing. Anchor weight is 300 milligrams. One anchor is supplied with each chamber. Bottom coverslip size is 22 x 40 mm. Order with P-1 or PH-1 platform on page M112.

Catalog No.	$	Model	Product
BS4 64-0228		RC-22	Recording Chamber for Tissue Slice with SHD-22L/2 Anchor
BS4 64-0229		RC-22C	Recording Chamber for Tissue Slice with SHD-22CL/2 Anchor
Additional Anchors			
BS4 64-0246		RC-22L/2	Slice Anchor for RC-22 (1.5 mm)
BS4 64-0247		RC-22CL/2	Slice Anchor for RC-22C (1.5 mm)

Fast Exchange Recording Chamber RC-24 (40 µl) & RC-24E (50 µl)

The bath volume in these two models is the smallest of the open style chambers. This design allows very fast solution exchange for a variety of applications including patch clamp and studies in electrophysiology. The small bath volumes are especially useful when using drugs in small quantities. Both models are used with 22 mm square or 22 mm x 40 mm coverslips. Order with P-1 or PH-1 platform, see page M112.

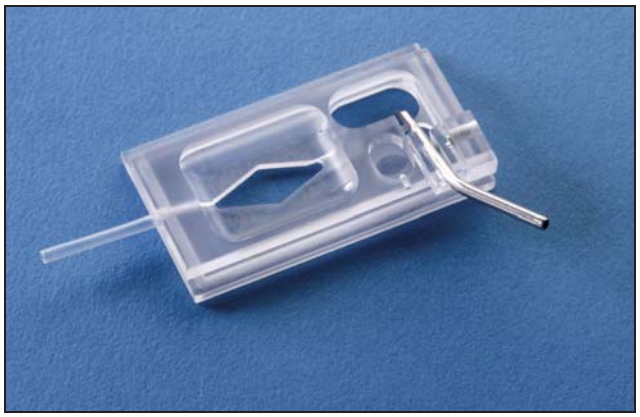
Catalog No.	$	Model	Product
BS4 64-0230		RC-24	Fast Exchange Recording Chamber
BS4 64-0231		RC-24E	Fast Exchange Recording Chamber

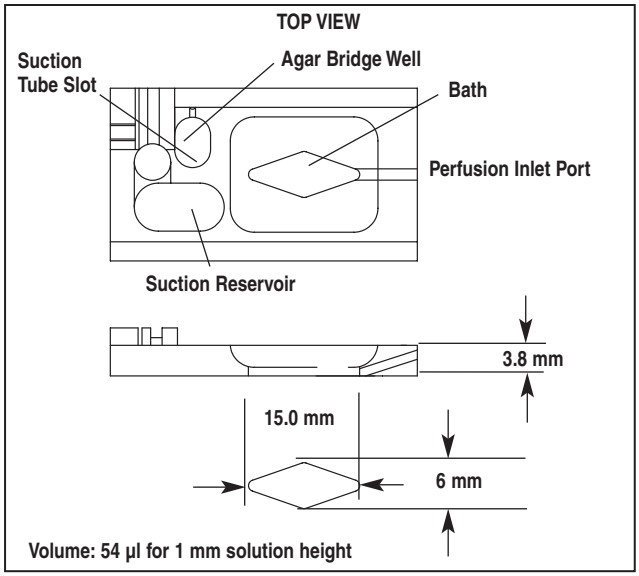
For Patch Clamps, see pages H2 to H5.

For Oocyte Clamps, see pages H20 to H26.

Slice Anchor Kits available, see pages M116 and M117.

Recording Chamber





Model RC-24N Fast Exchange Recording Chamber (54 µl)

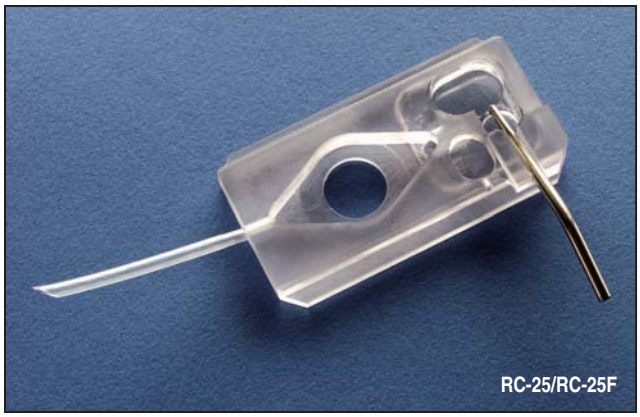
- Redesigned to improve flow characteristics
- 54 µl bath volume for 1 mm solution height
- Suction tube clamp

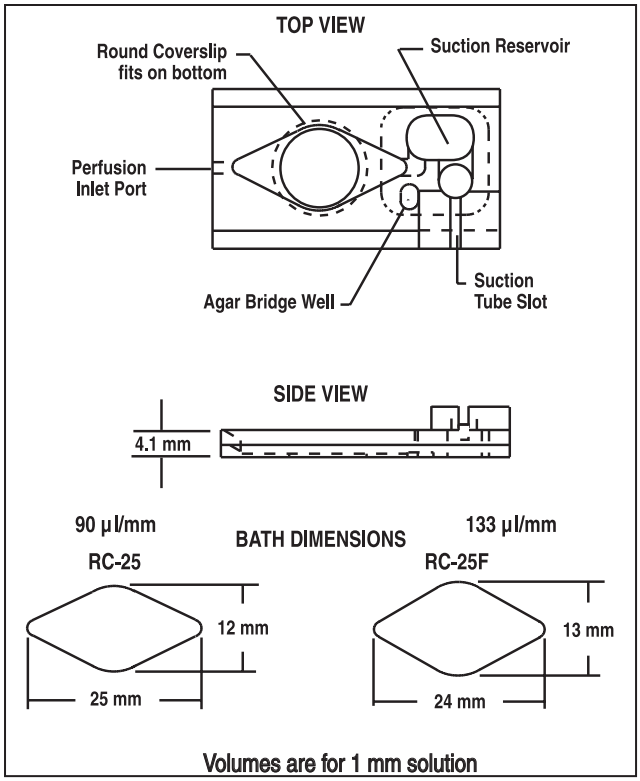
This chamber features the smallest bath volume of the open style chambers. This design allows very fast solution exchange for a variety of applications including patch clamp and studies in electrophysiology. Small bath volumes are especially useful when using drugs in small quantities. A 22 mm x 40 mm coverslip forms the chamber bottom.

Order with P-1 or PH-1 Platform. Standard accessories supplied are 22 x 40 mm #1 coverslips and PE-160 Tubing (10 ft.).

Catalog No.	$	Model	Product
BS4 64-0381		RC-24N	Fast Exchange Recording Chamber
Accessories/Replacement Parts			
BS4 64-0707		CS-22/40	Coverslips 22 x 40 mm #1, Box of 50

Series 20 Open Bath Recording/Imaging Chambers





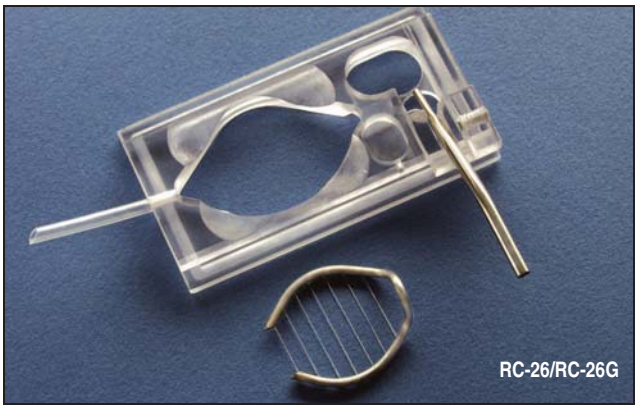
Round Coverslip Chambers RC-25 (90 µl) & RC-25F (133 µl)

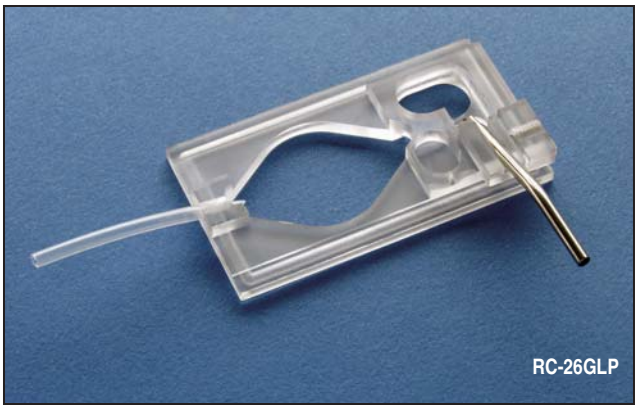
The bottom of these chambers is formed from standard size round coverslips, a widely used culture support for cells destined for physiological recording and/or imaging. RC-25 works with either 12 or 13 mm diameter coverslips and RC-25F uses 15 mm coverslips. RC-25 is ordered with P-3 or PH-3 platform. RC-25F is ordered with P-4 or PH-4 platform, see page M112 for platform information.

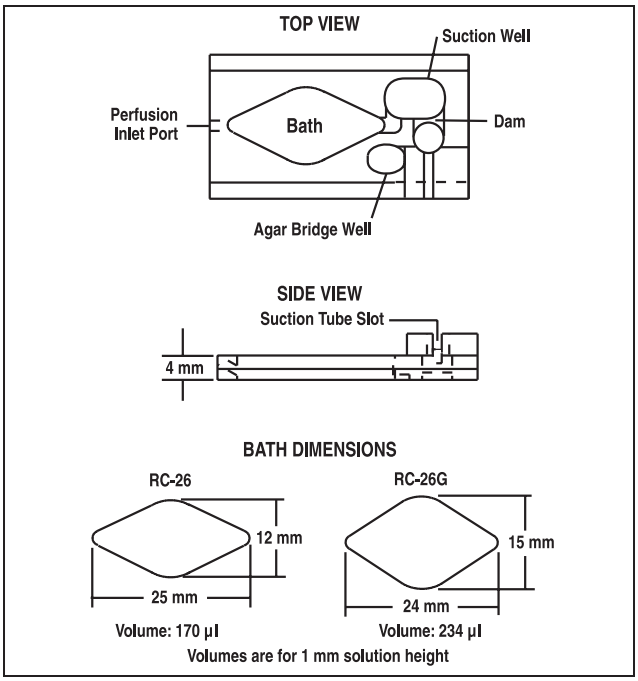
These chambers are not designed for coverslip insertion from the top.

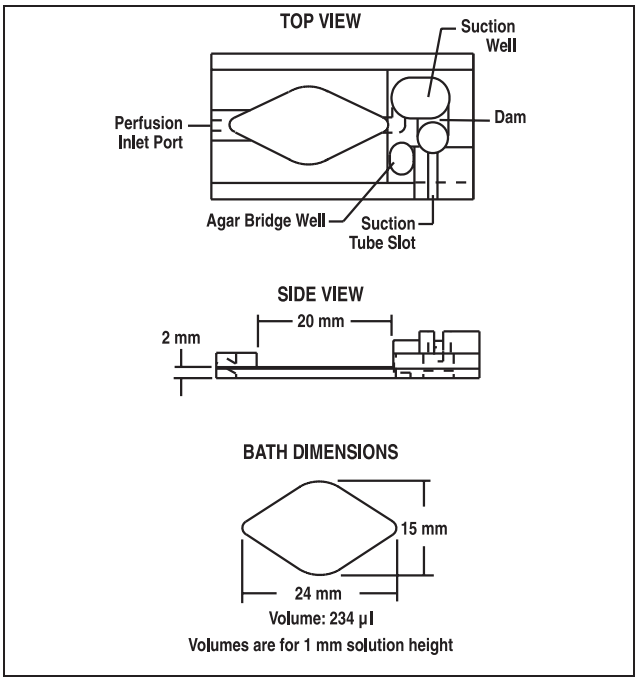
Catalog No.	$	Model	Product
BS4 64-0232		RC-25	Round Coverslip Recording Chamber (90 µl)
BS4 64-0233		RC-25F	Round Coverslip Recording Chamber (133 µl)

Series 20 Open Bath Recording/Imaging Chambers









Large Bath Recording Chamber RC-26 (170 µl) & RC-26G (234 µl)

These chambers accommodate larger slices and preparations and permit excellent access for electrodes. The larger baths also allow for insertion of a round coverslip from the top; a 12 mm in RC-26 and a 15 mm in RC-26G. Optional slice hold down anchors are offered for both models. The anchors are stainless steel frames with lycra threads at 2 mm spacing and weigh approximately 500 milligrams. Both models use a 22 x 40 mm coverslip on the bottom. Order with P-1 or PH-1 platform on page M112.

Catalog No.	$	Model	Product
BS4 64-0234		RC-26	Large Bath Recording Chamber
BS4 64-0235		RC-26G	Large Bath Recording Chamber
Optional Slice Anchors			
BS4 64-0252		SHD-26H/2	Slice Anchor for RC-26 (2 mm)
BS4 64-0255		SHD-26GH2	Slice Anchor for RC-26G and RC-26GLP (2 mm)

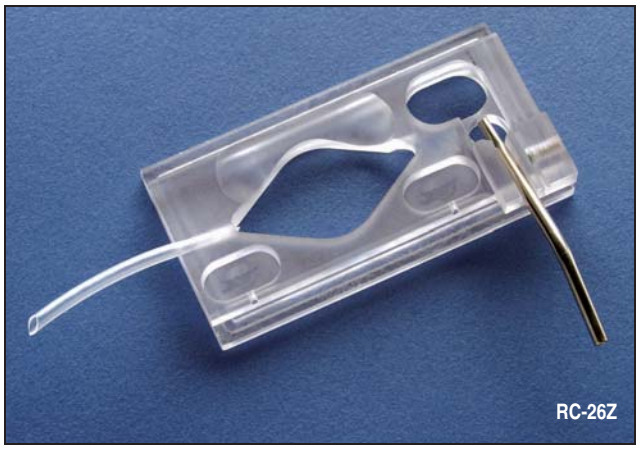
Low Profile Large Bath Recording Chamber RC-26GLP (234 µl)

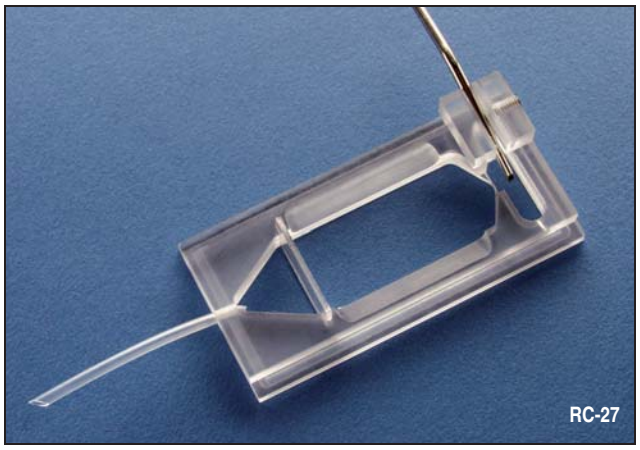
RC-26GLP is a low profile version of the RC-26G. The bath area of the chamber has been milled to a height of only 2 mm. The lower profile provides extra clearance for upright microscopes. Bottom coverslip size is 22 x 40 mm. Order with P-1 or PH-1 platform, see page M112.

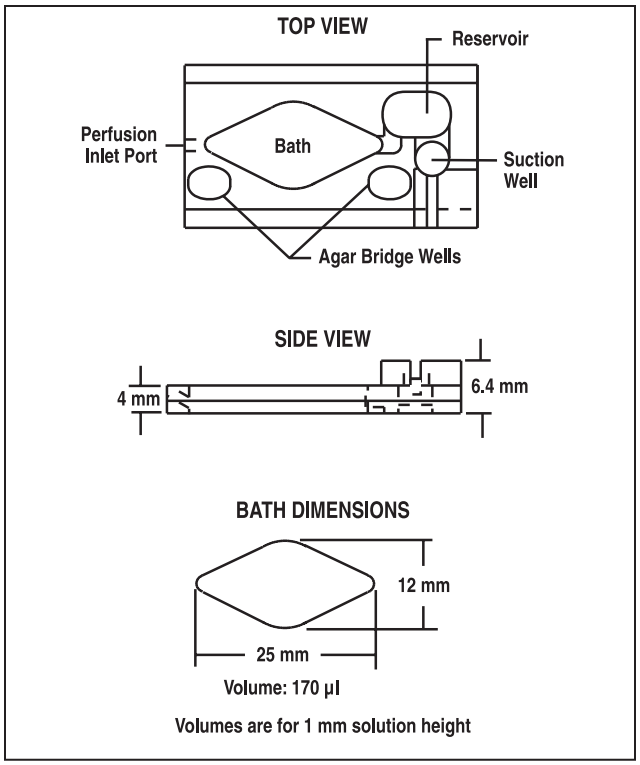
Catalog No.	$	Model	Product
BS4 64-0236		RC-26GPL	Low Profile Large Bath Recording Chamber
Optional Slice Anchors			
BS4 64-0252		SHD-26H/2	Slice Anchor for RC-26 (2 mm)
BS4 64-0255		SHD-26GH2	Slice Anchor for RC-26G and RC-26GLP (2 mm)

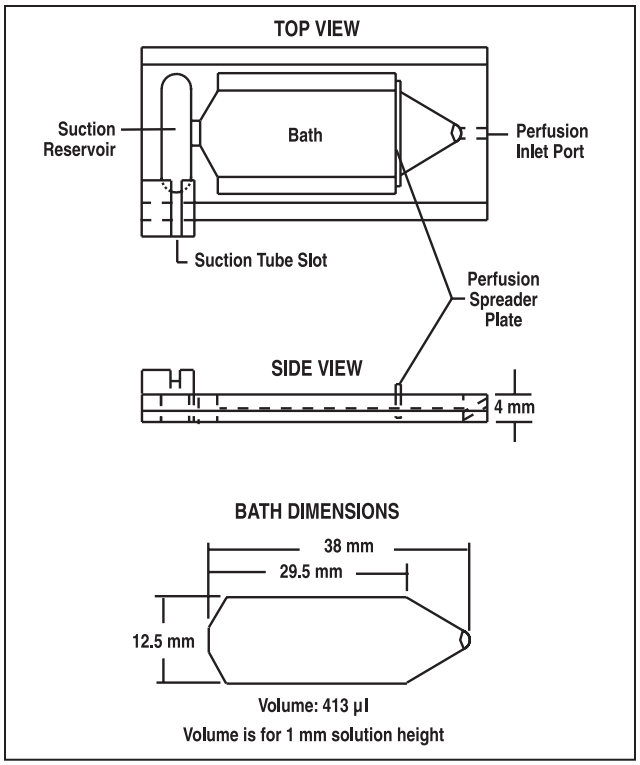
Other Anchor Weights and Spacings available, see page M116

Series 20 Open Bath Recording/Imaging Chambers









Large Bath Chamber for Oocyte Recording RC-26Z (170 µl)

Similar to the RC-26 this chamber has two additional features for oocyte recording; the dam height in the suction well is increased to 2.5 mm to provide an adequate solution level in the bath and a second agar bridge well has been added to accommodate bath clamp electrodes. Bottom coverslip size is 22 x 50 mm. Ordered with P-1 or PH-1 platform, see page M112.

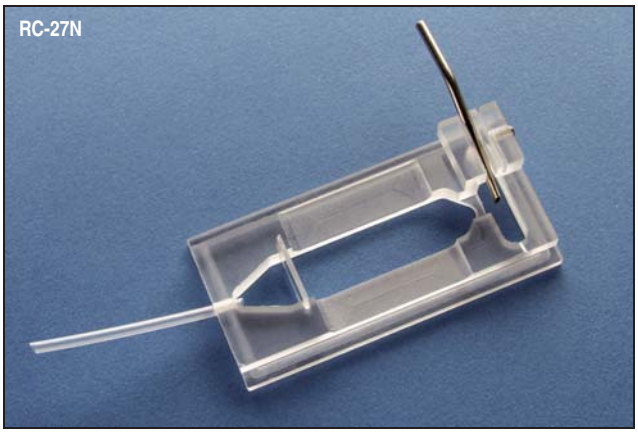
Catalog No.	$	Model	Product
BS4 64-0237		RC-26Z	Large Bath Oocyte Recording Chamber RC-26Z

Very Large Bath Chamber RC-27 (413 µl)

This chamber and its evolutions on the following pages feature a slotted shaped bath. The rectangular bath of the RC-27 will accommodate large specimens or the insertion of coverslips (up to 12 x 24 mm) typically used for organotypic slice culture studies. An adjustable spreader plate at the bath input provides a uniform solution flow across the bath. The bottom coverslip size is 24 x 50 mm. Order with P-6 or PH-6 platform, see page M112. Slice anchor kit available, see page M117.

Catalog No.	$	Model	Product
BS4 64-0238		RC-27	Very Large Bath Recording Chamber

Series 20 Open Bath Recording/Imaging Chambers

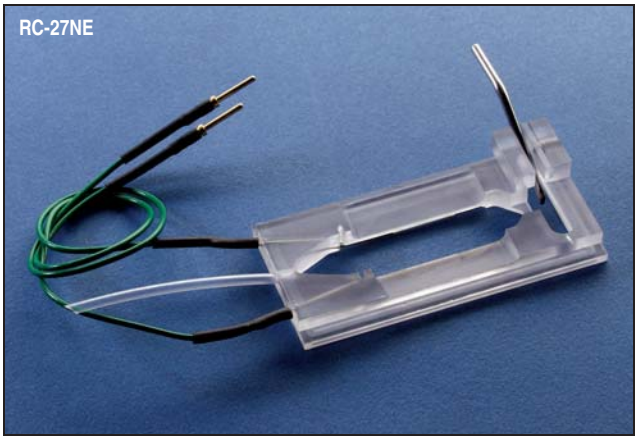


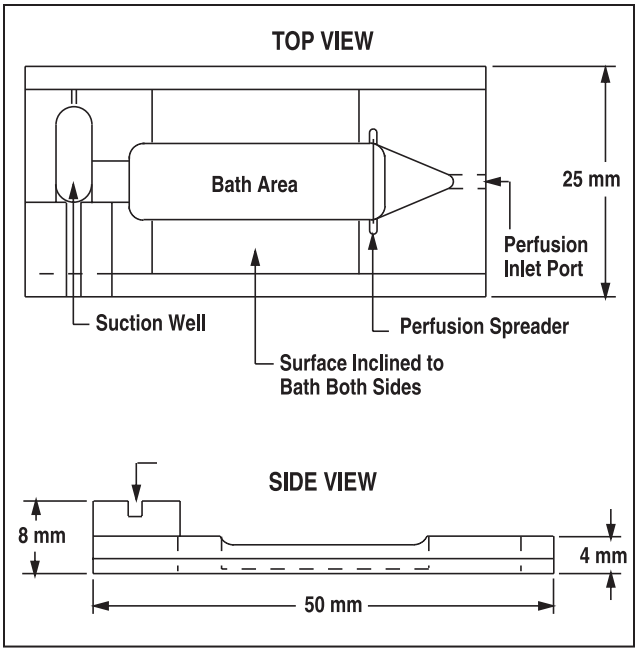
Narrow Bath Chamber RC-27N and Field Stimulation Chamber RC-27NE

Model RC-27N is a modified version of the RC-27 chamber with a narrower bath and smaller bath volume. Laminar solution flow is more stable than in the wider bath models.

Model RC-27NE is for applications requiring field stimulation and is supplied with a pair of platinum electrodes. The electrodes are installed along the two parallel sides of the bath. Electrode leads are approximately 16 cm long and terminated with 1 mm diameter pins.

The RC-27N and RC-27NE chambers use a 24 x 50 mm coverslip on the bottom. Both models are used with either P-6 or PH-6 (heater) platforms, see page M112.





Specifications

RC-27N and RC-27NE

Material	Polycarbonate
Bath Dimensions:	
Length x Width	37 x 8 mm
Specimen Area	28 x 8 mm
Volume/mm of Solution Height	305 µl per mm of solution
Standard Accessories Supplied:	PE-160 Tubing (10 ft) 24 x 50 mm #1 Coverslip, pkg. of 50
Platforms Used With:	P-6 Plain Platform PH-6 Heating Platform

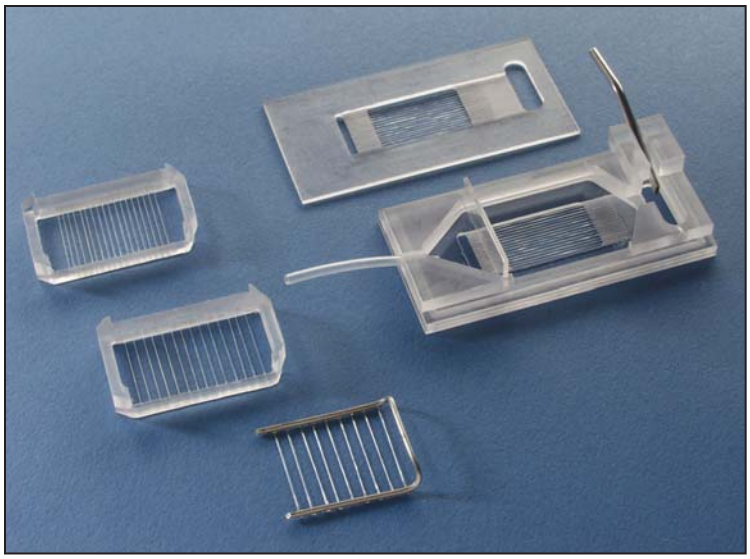
Catalog No.	$	Model	Product
BS4 64-0239		RC-27N	Narrow Bath Recording Chamber*
BS4 64-0240		RC-27NE	Narrow Bath Recording Chamber with Field Stimulation*

**Note: RC-27N and RC-27NE Chambers used with either P-6 or PH-6 (Heater) Platforms and Stage Adapter, see pages M112 to M115.*

For our complete line of Platforms and Adapters, see pages M112 to M115.

Slice Hold-Downs available in Kits, see page M117.

Large Bath Chamber RC-27L

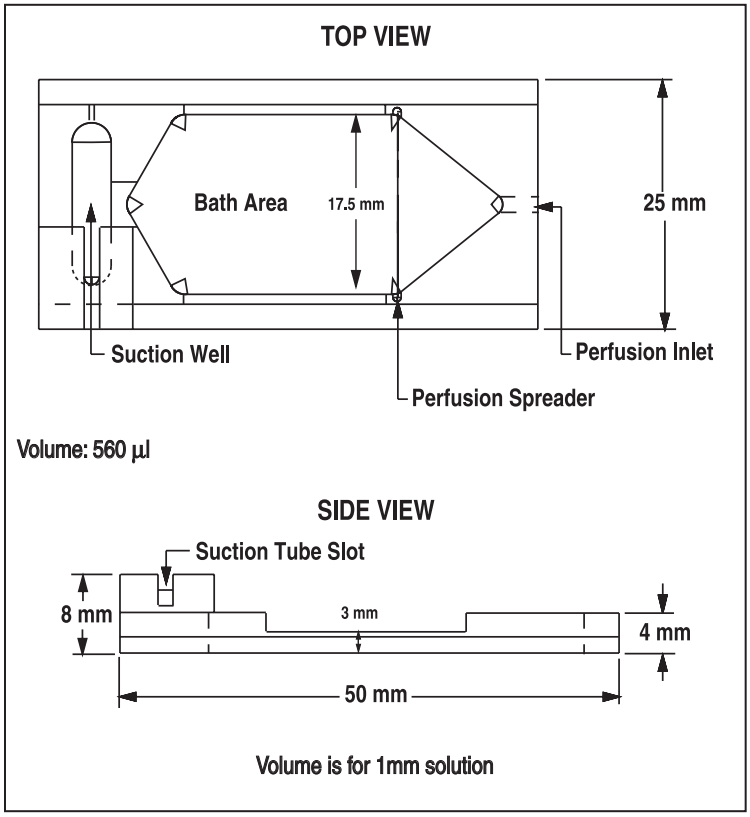


The RC-27L chamber is designed for slice studies where solution above and below the slice is desired. The large bath size and platform design also provide good access for immersion optics and electrodes.

The slice rests on a support 0.5 mm above the coverslip and is held in place by a slice anchor hold-down. Both support and hold-down use fine lycra thread to secure the slice in place allowing maximum access to the preparation. Thread spacing is 1 mm on the slice support.

Choice of Slice Hold-Down

Two hold-down styles are available: a stainless steel "harp" and a rectangular plastic frame. While the weight of the metal harp holds the slice in place, the plastic frame relies on a close apposition between itself and the side walls of the bath. Hold-downs are available with thread spacing of 1, 1.5 and 2 mm, and are sold separately. See accessoreis for selection of slice hold-down.



Specifications

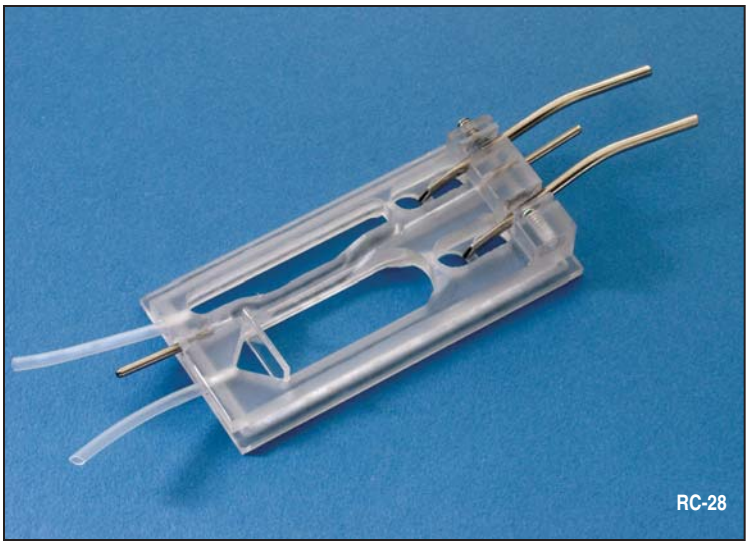
Material	**Polycarbonate**
Bath Dimensions	
Size, L x W	38 x 18 mm
Specimen Area	23 x 18 mm
Volume	560 µl per mm of solution height
Std. Accessories Supplied	1. SS-3 Slice Support 2. PE-160 Tubing (10') 3. 24 x 50 mm #1 Coverslip, pkg. of 50
Platforms Used With	1. P-6D Plain Platform 2. PH-6D Heater Platform

Catalog No.	$	Model	Product
BS4 64-0241		RC-27L	RC-27L Chamber
Accessories (Spare or Replacements)			
BS4 64-0273		SS-3	SliceSupport
BS4 64-0256		SHD-27LH/10	Metal Slice Hold-Down, 1 mm
BS4 64-0257		SHD-27LH/15	Metal Slice Hold-Down, 1.5 mm
BS4 64-0258		SHD-27LH/2	Metal Slice Hold-Down, 2 mm
BS4 64-0259		SHD-27LP/10	Plastic Slice Hold-Down, 1 mm
BS4 64-0260		SHD-27LP/15	Plastic Slice Hold-Down, 1.5 mm
BS4 64-0261		SHD-27LP/2	Plastic Slice Hold-Down, 2 mm

**Note: RC-27L Chambers require Platform P-6D of PH-6D, see page M112, and Microscope Stage Adapter, see pages M114 and M115.*

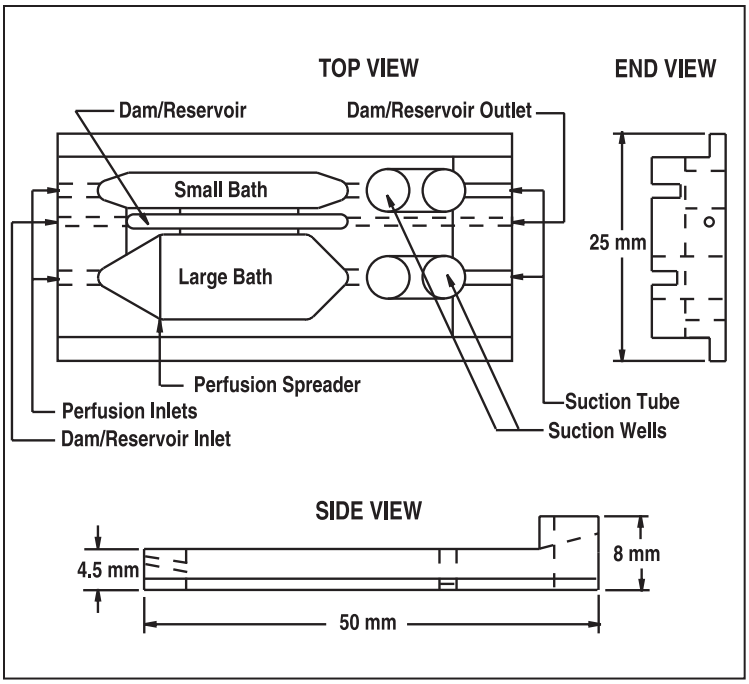
For a complete listing of individual Slice Hold-Downs and kits, see pages M116 and M117

Excised Patch Chamber RC-28



This chamber is designed for electrophysiological recordings of excised patches. The dual bath construction permits exchange of the solution surrounding the membrane patch without contamination of the entire population. The chamber consists of two independent bath compartments separated by a dam/reservoir which functions as a gate and barrier to prevent mixture of the solutions. The composition and exchange rate of each bath can be controlled independently.

After patching onto a cell in the larger bath compartment, the dam/reservoir is flooded with solution establishing a "solution bridge" between the two compartments. This enables secure transfer of the electrode attached cell to the smaller compartment. The dam/reservoir is then emptied by vacuum suction thus separating the two baths.



Specifications

Material	Polycarbonate
Small Bath Dimensions:	
Length x Width	28 x 3.8 mm
Specimen Area	20 x 3.8 mm
Volume	111 µl per mm of solution height
Large Bath Dimensions:	
Size, L x W	28 x 9.5 mm
Specimen Area	21 x 9.5 mm
Volume	234 µl per mm of solution height
Standard Accessories Supplied	1. PE-160 Tubing 10 ft L 2. 24 x 50 mm #1 Coverslip, pkg. of 50
Platforms Used With	1. P-6 Plain Platform 2. PH-6 Heater Platform

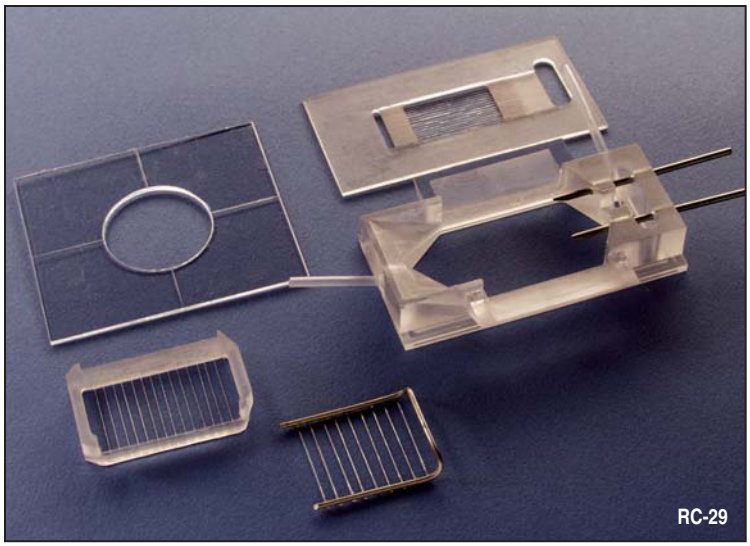
Catalog No.	$	Model	Product
BS4 64-0243		RC-28	Excised Patch Recording Chamber*

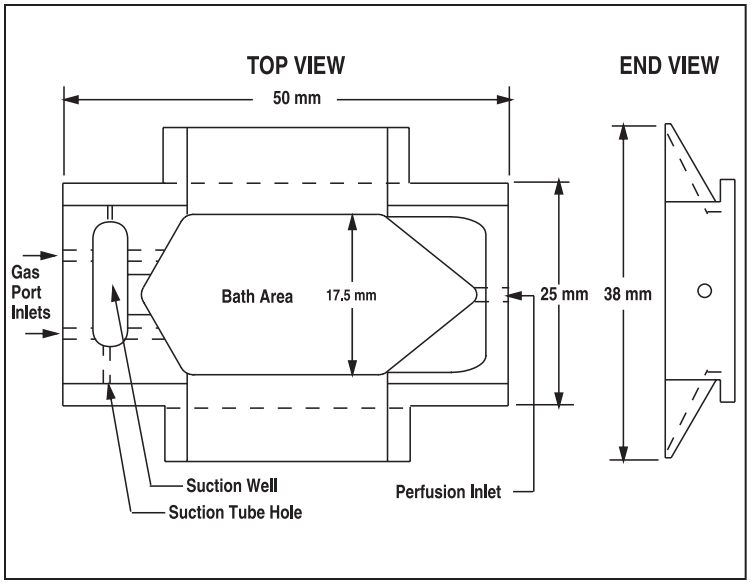
**Note: The RC-28 is used with either P-6 or PH-6 (Heater) Platform on page M112 and one of Stage Adapters on pages M114 and M115.*

For Patch Clamps, see pages H2 to H5.

For Patch Clamp Capillary Glass, see page M46.

Slice Chamber with Atmospherics RC-29





This chamber is designed for slice studies requiring the presence of gasses in fixed proportion. It is modeled after the RC-27L. This chamber is supplied with a slice support. It has two ports at the top of the chamber for the input of gasses. You must select a slice hold-down to complete your assembly. See listing below.

Specifications

Material	Polycarbonate
Bath Dimensions:	
Size, L x W	38 x 18 mm
Specimen Area	23 x 18 mm
Volume	629 µl per mm of solution height
Std. Accessories Supplied	1. SS-3 Slice Support 2. Chamber Cover 3. PE-160 Tubing (10') 4. 24 x 50 mm #1 Coverslip, pkg. of 50
Platforms Used With	1. P-6D Plain Platform 2. PH-6D Heater Platform

Catalog No.	$	Model	Product
BS4 64-0244		RC-29	RC-29 Chamber with Slice Support*
Accessories (Spare or Replacements)			
BS4 64-0273		SS-3	Slice Support
BS4 64-0256		SHD-27LH/10	Metal Slice Hold Down, 1 mm
BS4 64-0257		SHD-27LH/15	Metal Slice Hold-Down, 1.5 mm
BS4 64-0258		SHD-27LH/2	Metal Slice Hold-Down, 2 mm
BS4 64-0259		SHD-27LP/10	Plastic Slice Hold-Down, 1 mm
BS4 64-0260		SHD-27LP/15	Plastic Slice Hold-Down, 1.5 mm
BS4 64-0261		SHD-27LP/2	Plastic Slice Hold-Down, 2 mm

**Note: RC-29 Chambers require Platform P-6D or PH-6D and Microscope Stage Adapter, see pages M112 to M115.*

Slice Hold-Downs available in Kits, see page M117.

NEW SIU-102 Stimulus Isolation Unit - Bipolar High Current

- Constant Current and Constant Voltage modes
- Bipolar, Pulse and DC modes
- Optical coupling is used to isolate the stimulator from pulse source
- Current up to 100 mA

Designed for use with Warner imaging chambers with field stimulation electrodes, the SIU-102 features optical isolation at the input and transformer isolation at the output. Timing pulses can be controlled by any device capable of generating a TTL level positive pulse – a computer with data acquisition, for example.

Positive or negative pulses, positive or negative DC, and bipolar pulses are possible in constant current or constant voltage delivery modes. For bipolar delivery, a positive pulse during the input pulse is followed immediately by a negative pulse of equal duration and amplitude. Bipolar pulse widths from 100 µs to 100 seconds per each polarity are possible.

Output amplitude is set using a range mode switch in conjunction with a ten-turn potentiometer to set a percentage of the selected range.

Indicator lights keep the user apprised of the following:

High voltage: Lights red when output voltage above 30 volts.

Compliance: Lights when impedance across output is too high for current setting.

T>100 Sec: Lights when pulse width input is longer than 100 seconds in Bipolar mode.

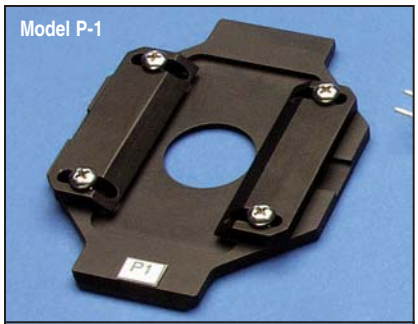
Ext. Trigger: Lights when a valid input is applied to the Pulse In BNC.

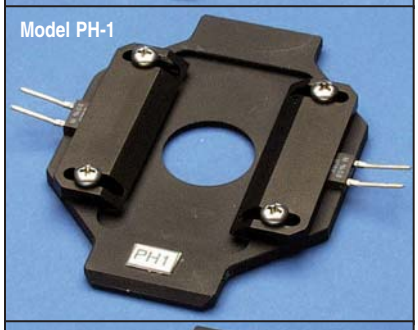
Catalog No.	$	Model	Product
BS4 64-1424		SIU-102	Stimulus Isolation Unit
BS4 64-1425		CC-102	Cable, male banana to 1 mm jacks (for use with Warner field stimulation chambers)

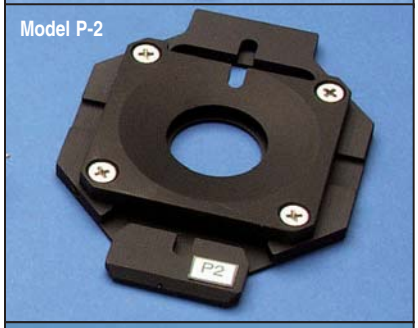
Specifications

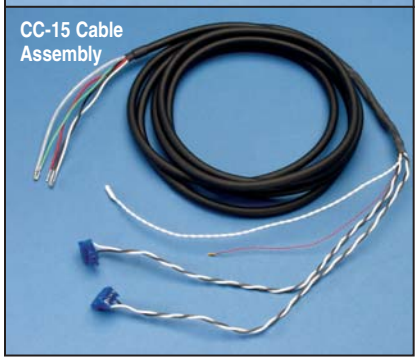
Output Waveform	DC, Current Pulse or Voltage Pulse
Output Current Ranges	1, 10, and 100 mA
Output Voltage Ranges	10 and 100 V
Output Impedance	10 V Range: 1 KΩ Voltage Mode 100 V Range: 10 KΩ
Output Compliance	100 V
Output Polarity	Selected by Mode Switch Red connector is positive in any positive mode Red connector is negative in any negative mode
Amplitude Control	Multi-turn dial
Input Pulse Requirements	TTL level, positive pulse 3 volt, 1 mA minimum Minimum Pulse Width: 100 µs Maximum Pulse Width: 100 s (Bipolar Mode Only)
Input Connector	BNC
Output Connector	Banana Jacks
Power Requirements	90 to 270 VAC, 50/60 Hz, 10 VA
Physical Size, H x W x D	8.9 x 20 x 25.4 cm
Shipping Weight	3 kg
Warranty	Two years, parts and labor

Series 20 Platforms









Series 20 Platforms

The platform functions as a base for the chamber and provides clamping to make a seal between the chamber and coverslip. They are machined from aluminum and finished with a black anodize. With the exception of the model P-2 and PH-2 platforms, Series 20 platforms feature sliding hold down clamps which permit rapid replacement of the chamber. The model P-2 and PH-2 platforms use a one piece clamp as shown above. Sliding clamps used on most models permit easy removal of the chamber to change the coverslip. Model P-2, see to left, uses a one piece clamp secured with 4 screws. Heater platforms are powered from a single channel of a Warner heater controller, see page M126. Connection to the controller is made with the CC-28 cable assembly, see below.

Series 20 Platforms

For Chamber Model	Aperture Size	Model	Plain Platform	$	Model	Heater	$
RC-22/22C/24/24E 26/26G/26GLP/26Z	17.8 mm	P-1	BS4 64-0277		PH-1	BS4 64-0284	
RC-21B/21BR RC-21BRFS	17.5 mm	P-2	BS4 64-0278		PH-2	BS4 64-0285	
RC-25	9.5 mm	P-3	BS4 64-0279		PH-3	BS4 64-0286	
RC-25F	13.0 mm	P-4	BS4 64-0280		PH-4	BS4 64-0287	
RC-20/20H	12.0 mm	P-5	BS4 64-0281		PH-5	BS4 64-0288	
RC-27/27N/27NE/RC-28	18.9 x 35.6 mm	P-6	BS4 64-0282		PH-6	BS4 64-0289	
RC-27L/RC-29	18.9 x 35.6 mm	P-6D	BS4 64-0283		PH-6D	BS4 64-0290	

Heater Platform Cable Assemblies

The CC-28 cable assembly is used to connect any Warner heater platform to a TC-324B or TC-344B heater controller. The cable has two thermistors at the platform end; the control thermistor which attaches to the platform and a bead thermistor for monitoring the bath temperature. The CC-28 is provided with a 9 pin din connector to plug into the heater controller. An alternative cable, the CC-15, is available with no inboard connector for users who choose to use another power source.

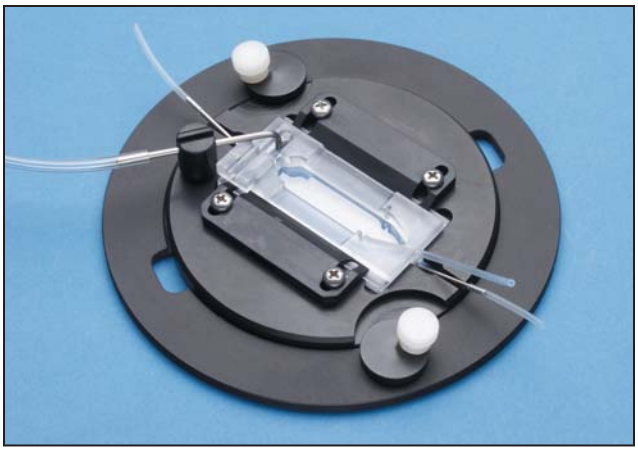
Heater Platform Upgrade Kit

Non-heater platforms can be converted to heater platforms with an upgrade kit consisting of a pair of resistive heaters, heat transfer pads and mounting screws. Tapped holes for the heaters are included in all plain platforms. The only tool required for installation is a small Philips screwdriver. The kit is ordered with either the CC-28 or CC-15 cable assembly.

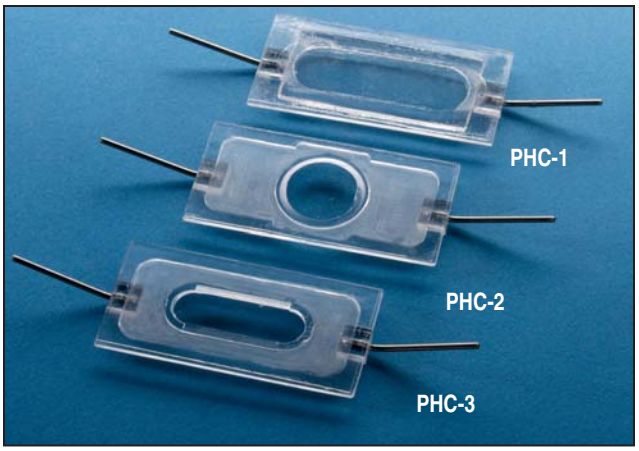
Note: Older models may not be upgradeable. Consult our technical support department.

Catalog No.	$	Model	Product
BS4 64-0106		CC-28	Cable Assemblies with Connector for TC-324B/344B
BS4 64-0303		CC-15	Cable Assemblies with Tinned Leads at Connector End
BS4 64-0304		PU-28	Platform Upgrade Kit with CC-28 Cable Assembly
BS4 64-0305		PU-15	Platform Upgrade Kit with CC-15 Cable Assembly

NEW PHC Series Heater/Cooler Jackets



Model PHC-3 shown with mounting platform and mounted in a Nikon stage adapter



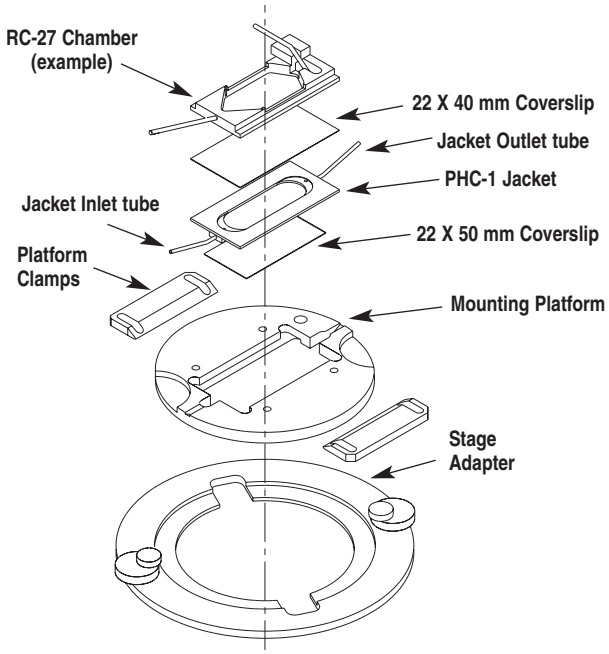
Individual heater/cooler jackets shown without mounting platform

- Designed for Series 20 chambers
- Optimized for the SC-20 In-line Solution Heater/Cooler
- Jackets available for upright and inverted microscopes
- Maintains temperature in both perfused and static baths

The Warner PHC Heater/Cooler Jackets are designed to bring heating and cooling to our classic Series 20 Imaging and Recording Chambers. Accurate temperature control from 5° to 50°C can be achieved using the PHC jackets in concert with the SC-20 Dual In-line Solution Heater/Cooler. Heated or chilled water flows from the SC-20 into the PHC jacket in direct thermal contact with the chamber bottom coverslip.

The PHC-1 is used for upright microscopes and provides a complete thermal barrier between the chamber-forming coverslip and the local environment. The PHC-2 and PHC-3 are designed for inverted microscopes and provide either rectangular or round openings. (See ordering information for chamber jacket compatibility.)

Heater/Cooler Jackets are provided with a mounting platform, which replaces the standard platforms used with Series 20 chambers. The platform functions as a base for the jacket /chamber sandwich and provides the clamping pressure to make a tight seal. Mounting platforms are machined from black Delrin and are compatible with all Series 20 stage adapters.



Assembly of Series 20 chamber with cooling jacket and stage adapter

Ordering Information

Catalog No.	$	Model	For Chamber Model	Aperture Size
BS4 64-0354		PHC-1	RC-22/22C/24N RC26/26G/26GLP/26Z RC-27/27N/27NE/RC-28 RC-27L/RC-29	17.0 x 37 mm
BS4 64-0355		PHC-2	RC-22/22C/24N RC-26/26G/26Z/26GLP	15 mm Dia.
BS4 64-0356		PHC-3	RC-27/27N/27NE	8.0 x 25 mm